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The effect of maturity, formulation, and storage time and temperature on the consistency of *Canned Cream Style* SWEET CORN

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THE EFFECT OF MATURITY, FORMULATION, AND STORAGE TIME AND TEMPERATURE ON THE CONSISTENCY OF CANNED CREAM STYLE SWEET CORN

D. ROBERT DAVIS and WILBUR A. GOULD

INTRODUCTION

The canning of uniform high quality cream style sweet corn requires that the consistency be accurately controlled. In order to properly control the consistency, the factors upon which this attribute is dependent must be properly evaluated. Variety, maturity, and formulation have long been realized as important variables upon which the consistency is dependent (2, 5, 11, 15, 19). It has also been suggested that the storage temperature, percentage of washed-drained residue, and inherent starch content will have an important effect on the consistency of cream style corn (4, 13, 16). However, studies that actually evaluate these factors have been few in number and very narrow in scope. The basic objective in this study, therefore, was to evaluate some important factors that are believed to affect the consistency of cream style corn.

Cream style corn contains two portions: (1) The whole kernel portion consisting of the whole kernels, and (2) The cream portion, consisting of corn material obtained by "capping" the kernels and scraping the kernel and its contents from the cob. When the kernel portion is kept within a reasonable range, it will have only a slight, if any, affect on the consistency (4). The cream portion, however, is believed to be the important inherent factor determining the consistency.

The amount of starch in the cream portion increases as the maturity increases. It is common practice in the canning of cream style corn to make the cream style corn thick at the mixer, then thin it to the desired consistency with added water, thus using maturity as the variable and water as the control. A second objective was, through the study of consistency patterns of several formulations, to establish the maturity-water relationship and to evaluate its effect on the consistency of the cream style corn.

The starch concentration can be increased by the addition of starch in the formulation. With the introduction of the waxy maize type of starch and the ensuing successful use in foods, the possibility of starch type as well as the starch amount, as a factor affecting consistency, was considered. A further objective, therefore, was to evaluate both the amount and type of added starch in relation to their effect on the consistency.

The storage time and temperature is known to affect consistency, but no studies which evaluate these factors as they concern consistency in cream style corn have been reported to date, thus the final objective was the consideration of storage time and temperature and their relationship to the consistency of cream style corn.

REVIEW OF LITERATURE

The quality of canned cream style sweet corn is dependent upon several attributes which are listed in the United States Department of Agriculture tentative Standards for Grades of Canned Cream Style Corn (17). The factors of color, absence of defects, and flavor, although important attributes of quality, they are in no way directly related to the consistency of the finished products. However, both the consistency and the tenderness and maturity factors are important and must be considered in the measurement and control of consistency in cream style corn.

Consistency, for grading purposes, refers to the degree of smoothness and the separation of free liquor (6, 10). The highest score or rating is given to corn with a medium heavy cream-like consistency. Corn which is less creamy or has a heavy consistency is rated lower. As far back as 1917 Remington (14) noted, "a definite lack of uniformity, most prominently in consistency, between Fancy, Extra Standard, and Standard grade cream style corn." This lack of uniformity is still recognized as a problem in the cream style corn industry (7).

A food grader's or inspector's estimate of the rating as to the "cream-like consistency" which is desired is influenced by several complex factors. Although some of the more important factors have been studied and evaluated, many of the results have been contradictory. Practically every worker in the field has recognized the importance of maturity on the finished consistency of the cream style corn (7, 9, 10, 15). Huelsen (10) stated that maturity was important in determining consistency because as the corn advances in maturity the total sugars decrease and the insoluble polysaccharides increase. Physically, the

kernel contents change from a milky to a creamy texture which is followed by the "dough" stage of maturity with the moisture decreasing at a rapid rate. Wilbur (19), agreeing with this statement, stated that cream style corn has fluid properties which are controlled by the carbohydrate material in the raw corn, particle size and distribution, and the extent of dilution. Smith (16) explained that more mature corn will take up more water than immature corn. Meister (12) reported that young corn should be thicker when delivered to the filler than more mature corn since the young corn will not thicken on cooking nearly as much as the more mature corn.

In the formulaton of cream style corn, which includes the addition of sugar, salt, water, and starch, only water and starch are considered by most workers to affect the consistency (5, 9, 10, 12, 20). In fact, Wiley **et al.** (20) reported that water, added starch, and starch in the cream component were the factors chiefly responsible for the processed consistency of cremogenized corn. In some of the studies water is not considered as a factor affecting the consistency; but is considered as a controller of the consistency. The addition of water to "heavy" cream corn is the surest and easiest method of controlling consistency.

Smith (15) recommends that all the factors contributing to the consistency be taken into consideration, then adjusting the amount of water in the final prepared batch. This is the basic method in use today. The Dezurik Automatic Viscosity and Density Regulator, as described by Graham (9) was developed for this purpose. Geidel (5) stated when the consistency is "heavy" the addition of water produced only a slight change in the consistency, but as the corn approaches the proper consistency, an addition of water produces a far greater change, so water must be added at this stage very cautiously.

Gabby (4) in his studies on cream style corn concluded that the other ingredients used in cream style corn have their effect, but only slightly modify the value imparted by the starch. The amount of starch to add to insure the proper consistency is usually agreed to be the result of experience gained from carefully controlled experiments at each particular corn factory (10, 15), and some workers indicate that it is not necessary to add starch when a more mature corn is being used (9, 10). For many years the quality or type of starch has been recognized as a factor which may affect the consistency of the finished corn (9, 15) but in practically all research the linear type of starch was used exclusively. Huelsen (10) reported that there is no definite evidence that the type of starch sold by one manufacturer is any better than that sold by any others.

Although several accurate methods of determining consistency have been developed, a method of correlating the consistency at the time of filling with the consistency after a given storage period has not been accomplished in a manner suitable for use by all segments of the industry. Davis (3), working with three consistency instruments, failed to obtain any useful correlations for predicting the changes in consistency during storage. Wiley **et al.** (20) working with cremogenized corn developed a nomograph in which it was possible to obtain a correlation coefficient of 0.90 between the consistency at the filler and processed consistency after 1, 3, 6, and 12 months storage. Geidel (5) stated that the time of maximum thickening of consistency will vary from six days to over six months, depending upon the maturity of the corn. Davis (3) reported that the maximum consistency of cream style corn manufactured from the variety Victory Golden did not occur until sometime after ten days storage. Smith (15) found that the thickness of the cream style corn after processing may be somewhat greater than the prepared batch and that the thickness of the corn after storage of a week or more will be greater than that just after processing.

Meister (13) reported that any changes in consistency of Fancy corn after packing are due to the lowering of the storage temperature. However, this conclusion has been challenged by other investigators (3, 10). Geidel (5) agreed that storage temperature is a factor which will cause a change in consistency during storage. Both Meister (13) and Geidel (5) found that the relationship between consistency and temperature is an inverse one.

EXPERIMENTAL METHODS

GROWING PRACTICES:

The raw sweet corn used in the preparation of the cream style corn was obtained from sweet corn plots located on the Horticulture Farm at the Ohio State University, Columbus, Ohio, and was grown during the 1957 and 1958 seasons. The variety Deep Gold, an important hybrid in general use, was used throughout this study. The cultural practices which were followed were typical of this area for non-irrigated sweet corn.

Samples from the 1957 season were taken, in most cases, from four harvests of four plantings. Samples of the corn taken during the 1958 season were from one to three harvests of five plantings. The first harvest in 1957 was made on August 22, and on August 18 in 1958. Harvesting was continued until September 16 in 1957 and September 23

in 1958, with two to four day intervals between most pickings. The harvest dates by year and planting are given in Table 1.

TABLE 1.—Dates of harvest for Deep Gold sweet corn for the years 1957 and 1958

Year	Planting	Harvest		
		1	2	3
1957	1	8–22	8–24	----
	2	8–27	9–5	----
	3	9–7	9–11	----
	4	9–16	----	----
1958	1	8–18	8–21	8–25
	3	9–13	----	----
	4	9–19	----	----
	5	9–23	----	----

PROCESSING METHODS:

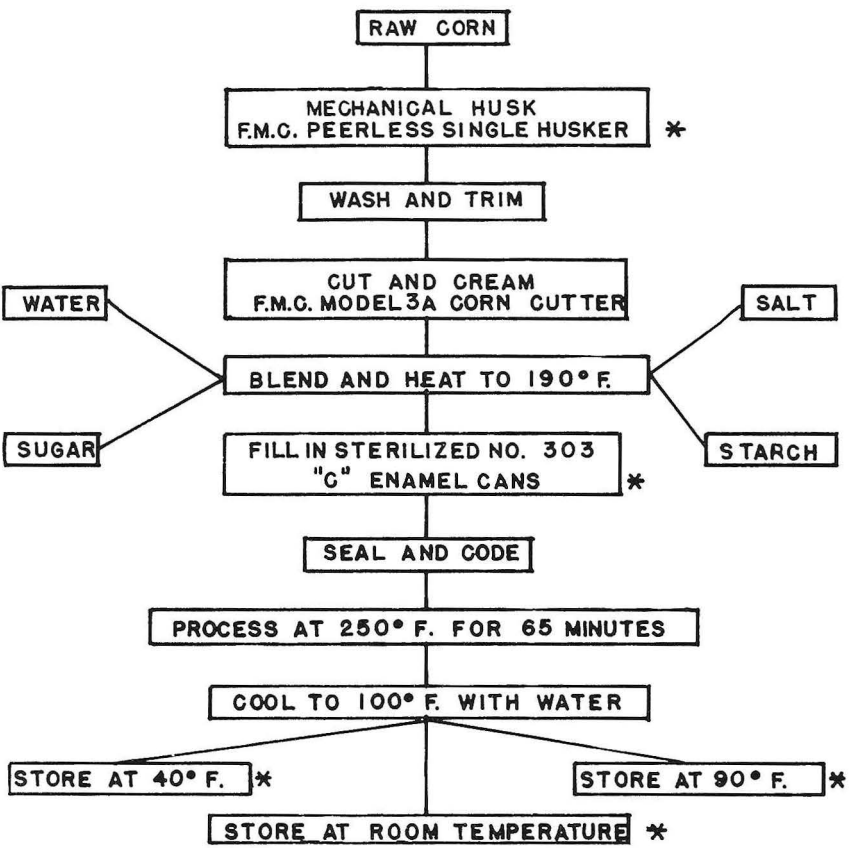
The sweet corn was harvested by hand and delivered to the Horticultural Products pilot plant, where it was canned on the basis of 50 pounds of cut corn per batch of cream style corn. All the corn used in this study was field run (ungraded) and the number of batches per harvest varied proportionally with the yield. The cream style corn was processed by the conventional method according to acceptable commercial practices. The processing of the cream style corn proceeded as follows (see Chart I):

1. The corn was harvested by plantings.
2. Husked with the aid of a Food Machinery Corporation Peerless Mechanical Corn Husker.
3. Trimmed, soaked, washed, and cleaned.
4. Cut on a Food Machinery Corporation Universal Corn Cutter, Model 3A. The cut was approximately 5/16 of an inch deep and the remaining kernel residue was scraped from the cob. The resulting kernels and cream portions were discharged into a stainless steel pan, mixed thoroughly, and weighed into 50 pound batches.
5. The mixture was emptied into a ten gallon steam mixing tank containing a mechanical agitator. Predetermined amounts

of water, salt, and sugar were added and the mixture heated to 190° F. Starch was added to some batches at this point and the mixture was held at 190° F. for five minutes. The mechanical agitator was rotated continuously throughout the preparation, heating, and filling period.

6. At the end of the heating period the steam was turned off and the hot cream style corn was filled into No. 303 size C-enamel cans.

7. The cans were coded and sealed using a steam flow (17 p.s.i.) closure.



*SAMPLING POINTS FOR OBJECTIVE ANALYSIS

CHART I.—A flow sheet of the processing of cream style corn.

8. Processed in non-agitating retort for 65 minutes at 250° F.
9. Cooled promptly to a center can temperature of 100° F. in cold running water.
10. The first six cans and the last six cans of each batch were discarded and the remaining cans divided into three lots. The first lot was stored at 40° F., the second at room temperature (approximately 75° F.), and the third at 90° F.

QUANTITY PACKED:

During the two year period a total of 92 batches (approximately 4,000 cans) of cream style corn were processed. This included 50 batches of cream style corn packed in 1957 and 42 batches packed in 1958. The formulas of each batch, as percentage by weight, of the 1957 and 1958 packs are presented in Appendix Tables A and B, respectively.

OBJECTIVE DETERMINATION OF QUALITY OF RAW SWEET CORN AND UNPROCESSED CREAM STYLE CORN:

Objective quality analysis was made on samples taken twice from each harvest of the raw corn as it was discharged from the husker, the first sample involving corn which was incorporated in the first batch of the harvest and the second sample from corn which was destined for the

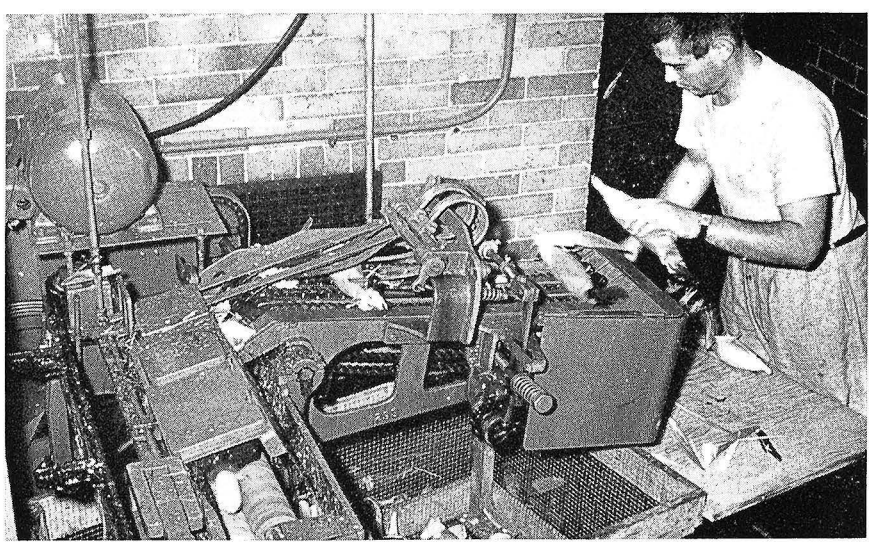


Fig. 1.—Pilot plant processing of cream style sweet corn showing mechanical husker.

last batch of the harvest. The time involved from the preparation of the first batch to the processing of the last batch was never longer than six hours. The results of these analysis of the raw corn samples for the 1957 and 1958 seasons are presented in Appendix Tables A and B, respectively. The methods of determination were as follows:

A. Moisture Content—Percentage moisture was determined by the Steinlite moisture method using the Steinlite Electronic Tester, Type LSC, according to the manufacturer's instructions. The percent moisture was determined on the 1957 samples only, and from the results of the tests the amount of water to add to the formulation was determined.

B. Specific Gravity—The specific gravity method requiring an approximate 100 gram sample was the same as that outlined by Gould, **et al.** (8). The specific gravity was determined on most of the 1957 and 1958 samples and in the 1958 season this method, rather than the moisture content, was used to determine the amount of water to add in the formulation.

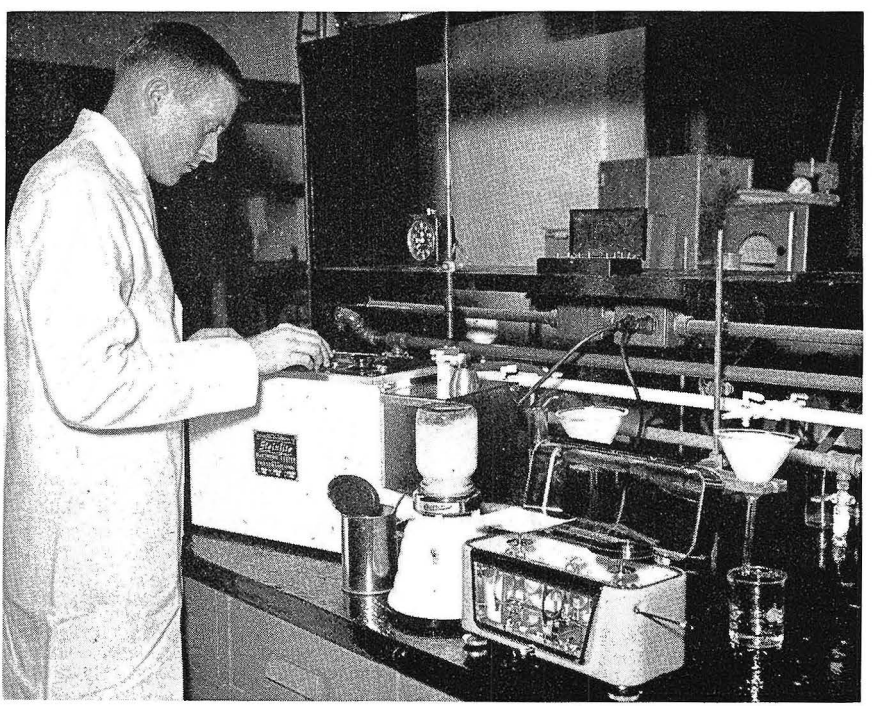


Fig. 2.—Determining the moisture content of sweet corn with the Steinlite Electronic Tester.

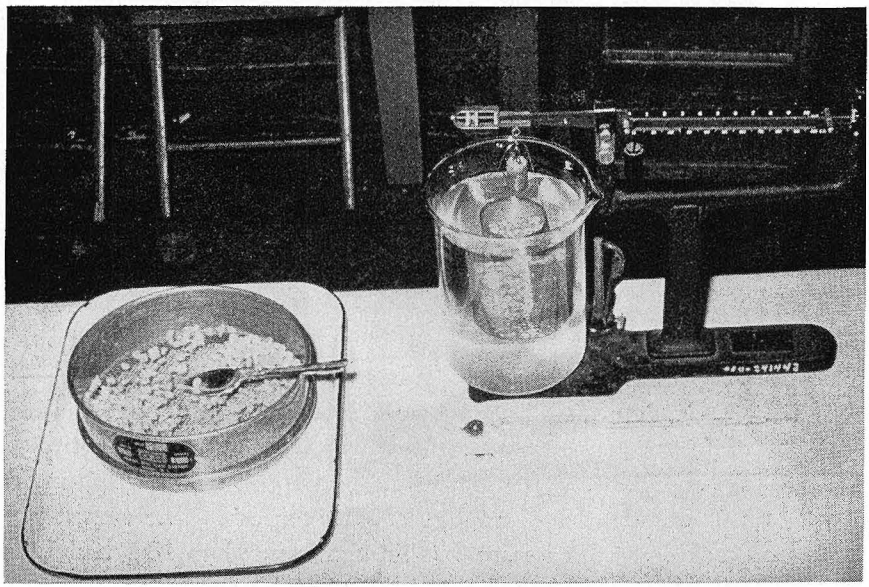


Fig. 3.—Apparatus for determining the specific gravity of raw sweet corn.

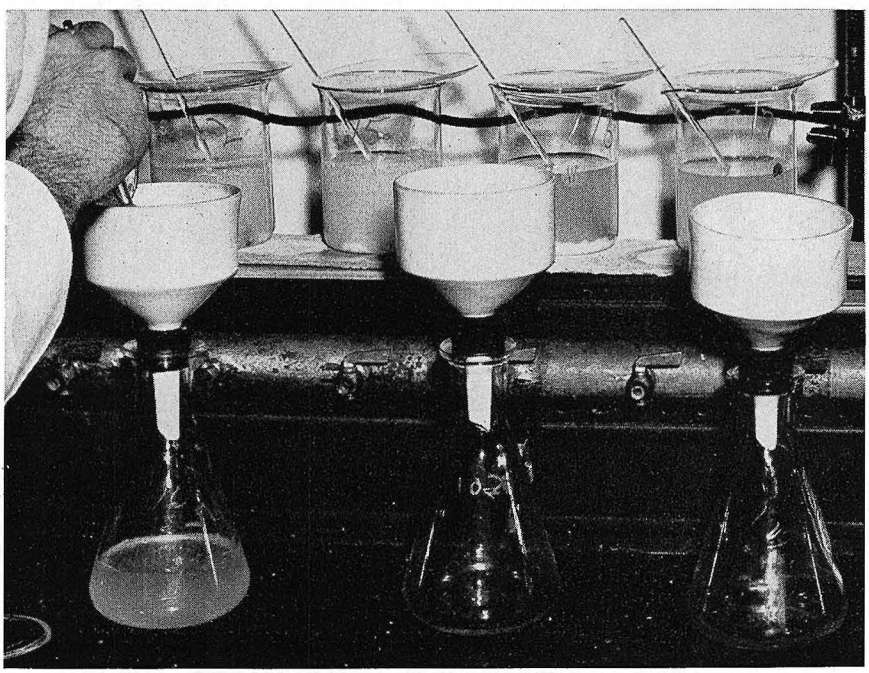


Fig. 4.—Determining the alcohol insoluble solids of raw sweet corn.

C. Alcohol Insoluble Solids Determination (A.I.S.)—The A.I.S. were determined using the Food and Drug Administration method (18).

The second set of samples was taken as the hot cream style corn was being filled into the sterilized cans. Two filled cans were sampled at this point. One sample was evaluated immediately for consistency, while the other sample was cooled at 78° F. before the consistency evaluation.

D. Consistency Determination—The consistency was determined with the aid of the Adams Consistometer (see Figure 5). The instrument consists of a polished circular metal plate with a diameter of 14 inches and marked with calibrated circles, beginning at the outside and continuing at quarter-inch intervals to within 1½ inches from the center. The consistency markings ranged from 0 (thin consistency) to 18 (thick consistency). Table 2 shows the relationship between the Adams readings and the distance of flow of the corn.

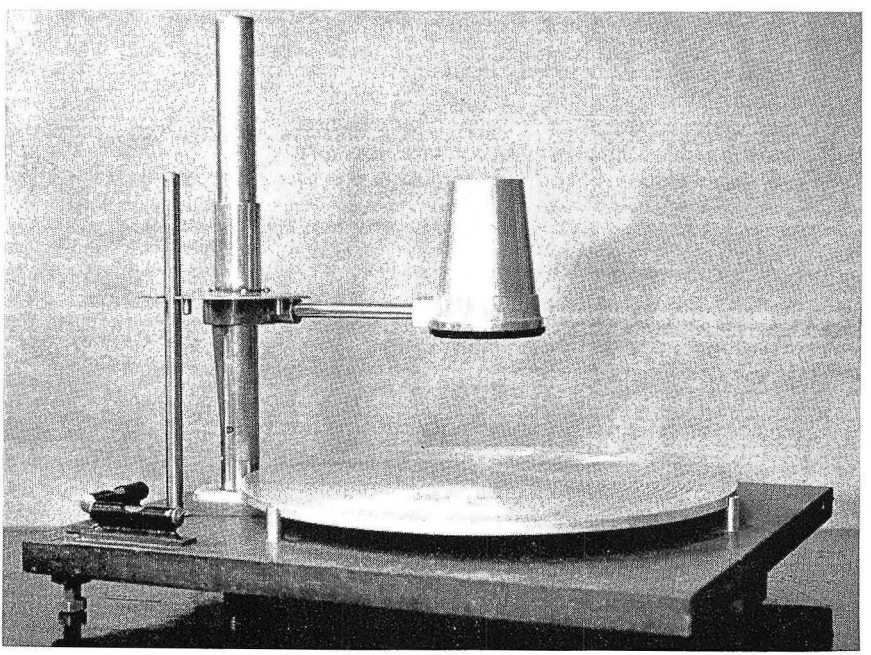


Fig. 5.—The Adams Consistometer.

TABLE 2.—A comparison of Adams values with spreading distance for consistency determinations of cream style sweet corn by the Adams Consistometer

Adams Value	Inches of Spread*
0	more than 12
1	12
2	11 ½
3	11
4	10 ½
5	10
6	9 ½
7	9
8	8 ½
9	8
10	7 ½
11	7
12	6 ½
13	6
14	5 ½
15	5
16	4 ½
17	4
18	less than 4

*Inches of spread indicates the flow of the cream style corn in all directions.

Directly above the center of the plate is a trunicated cone with an inside bottom diameter of three inches, an inside top diameter of two inches, and a height of 4 27/32 inches. The trunicated cone is held by an arm which is attached to a side pole. The arm is movable, and the trunicated cone may be raised and lowered to the center of the measuring plate. The consistency of the cream style corn was determined in the following way:

1. The instrument was first leveled by adjusting the leg screws in order to obtain uniform flow over the plate and the cone was lowered so it was tight against the center of the plate.
2. The corn was filled into the cone until it was level with the top of the cone. The samples which were measured while at 190° F. were not stirred; the samples which were cooled to 78° F. before testing were stirred approximately 30 seconds with a spoon.

3. The cone was raised and the corn was allowed to flow over the plate for 30 seconds.
4. At the end of this time the extent of flow of the product was taken at four equi-distant points on the plate. The average of these readings was recorded as the consistency of the cream style corn.

Since the consistency of the cream style corn was read at four places on the plate and then averaged, and since estimates of readings were no closer than 0.5, the final consistency was always in units no less than 0.25 Adams values.

OBJECTIVE DETERMINATION OF CONSISTENCY OF CANNED CREAM STYLE SWEET CORN:

Before the consistency evaluation, the cream style corn samples stored at 40° F. and 90° F. were allowed to stand at room temperature from 18 to 30 hours. The cream style corn packed during the 1957 season was evaluated for consistency at three time intervals: 1 day, 4 months, and 9 months. The procedure was the same as outlined previously except the samples were stirred by a mechanical stirrer for three minutes at 300 RPM before the consistency measurement. The percentage A.I.S. was determined on the room temperature storage samples at the four-month storage period.

The cream style corn stored at 40° F. and 90° F. durng the 1958 season was evaluated for consistency after storage periods of 2, 4, 6, 8, 10, 12, and 16 weeks, while the corn at room temperature storage was evaluated after storage periods of 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 16, 18, 22, and 24 weeks storage. Before each consistency measurement the cans of cream style corn were shaken vigorously for a period of 30 seconds. The percentage A.I.S. was determined on the samples in room temperature storage at the 16 week storage period.

FORMULATION:

The formulation for both the 1957 and 1958 season was varied in the amount of added water and the amount and type of added starch. The amount of corn, sugar, and salt was kept constant—50 pounds of corn, 3.5 pounds of sugar, and 0.35 pounds of salt.

A. Water—The amount of added water varied depending upon the maturity of the corn. In 1957 the moisture percentage of the raw corn was used as a guide to the amount of added water (Table 3). However, the moisture content was used

TABLE 3.—Batch formula for cream style corn based on the moisture percent of the raw sweet corn (1957 season)

Percent moisture (Steinlite)	Pounds of water added	
To 69.9 %	(a)—20 lbs.	(b)—27 lbs.
70.0 to 71.9 %	(a)—15 lbs.	(b)—22 lbs.
72.0 to 73.9 %	(a)—10 lbs.	(b)—15 lbs.
Over 74 %	(a)— 7 lbs.	(b)—12 lbs.

Batch	Formula
1	50 lb. corn (a) lb. water 3.5 lb. sugar 0.35 lb. salt 0 starch
2	50 lb. corn (a) lb. water 3.5 lb. sugar 0.35 lb. salt 100 gms. thin boiling linear starch (Fluftex)
3	50 lb. corn (a) lb. water 3.5 lb. sugar 0.35 lb. salt 100 gms. waxy maize starch (W-13)
4	50 lb. corn (a) lb. water 3.5 lb. sugar 0.35 lb. salt 100 gms. thick boiling linear starch (Purity NCS)
5	50 lb. corn (b) lb. water 3.5 lb. sugar 0.35 lb. salt 0 starch
6	50 lb. corn (b) lb. water 3.5 lb. sugar 0.35 lb. salt 100 gms. thin boiling linear starch (Fluftex)
7	50 lb. corn (b) lb. water 3.5 lb. sugar 0.35 lb. salt 100 gms. waxy maize starch (W-13)
8	50 lb. corn (b) lb. water 3.5 lb. sugar 0.35 lb. salt 100 gms. thick boiling linear starch (Purity NCS)
9	The same as Batch 1

only as an indicator and there were variations from the proposed water additions. These changes were determined primarily by the appearance of the cream style corn in the blending tank based on the readings from the Adams Consistometer. For example, if the corn was too thick (Adams value of eight or above) in the blending tank just before filling into the cans, then more water was added. Two different added water concentrations were used in each harvest and were dependent upon the maturity of the raw corn as shown in Table 3.

During the 1958 season the specific gravity of the raw sweet corn was used as a guide for the water additions (Table 4). Here again, however, the specific gravity was used only as an indicator and there were variations from the proposed water additions, based on Adams Consistometer values.

B. Starch—The batches of cream style corn within each harvest were varied as to the starch content and starch type. In the 1957 season the amount of added starch was either none or 100 grams of the three different starch types (a thin boiling linear starch (Fluftex), a thick boiling linear starch (Purity NCS), and a waxy maize starch (W-13). The variations of the 1958 season were no starch, 100 grams, 250 grams, or one pound per batch of two different starch types (the thin boiling linear starch (Fluftex) and the waxy maize starch (W-13). The added starch was mixed with water and added to the blending tank during the five minute heating period.

C. **Starch Types**—The three types of starch used in this study are characterized as follows:

1. Fluftex—Produced by the American Maize-Products Company, this starch is classified as a thin boiling, acid free starch with exceptional clarity (1).
2. Purity NCS—A product of the National Starch Company, this starch is classified as a thick boiling processed corn starch which is more resistant to high retort temperatures than ordinary corn starch (1).
3. W-13 Stabilizer—This starch is a waxy maize or amoica type starch and is produced by the American Maize-Products Company.

Appendix Tables A and B contain the formula of each batch of cream style corn, as percentage by weight, of the 1957 and 1958 packs, respectively.

TABLE 4.—Batch formula for cream style corn based on the specific-gravity of the raw sweet corn (1958 season)

Specific-gravity	Pounds of water added
To 1.060	(a)—10 lbs.
1.060 to 1.080	(a)—15 lbs.
1.080 to 1.100	(a)—20 lbs.
Over 1.100	(a)—25 lbs.

Batch	Formula
1	50 lb. corn (a) lb. water 3.5 lb. sugar 0.35 lb. salt 0 starch
2	50 lb. corn (a) lb. water 3.5 lb. sugar 0.35 lb. salt 100 gms. waxy maize starch (W-13)
3	50 lb. corn (a) lb. water 3.5 lb. sugar 0.35 lb. salt 100 gms. thin boiling linear starch (Fluftex)
4	50 lb. corn (a) lb. water 3.5 lb. sugar 0.35 lb. salt 250 gms. waxy maize starch (W-13)
5	50 lb. corn (a) lb. water 3.5 lb. sugar 0.35 lb. salt 250 gms. thin boiling linear starch (Fluftex)
6	50 lb. corn (a) lb. water 3.5 lb. sugar 0.35 lb. salt 1.0 lb. waxy maize starch (W-13)
7	50 lb. corn (a) lb. water 3.5 lb. sugar 0.35 lb. salt 1.0 lb. thin boiling linear starch (Fluftex)
8	The same as Batch 1

RESULTS AND DISCUSSION

The results of this study on canned cream style sweet corn are presented under the following headings:

A. The consistency patterns of canned cream style sweet corn of the variety Deep Gold.
B. The maturity-added water relationship and its effect on the consistency.
C. Added starch as a factor affecting the consistency.
D. Storage temperature and time and their effects on the consistency.

Where possible, the data relating to each of these relationships are interpreted statistically and summarized in tabular form in the following sections. The detailed data are presented in the Appendix Tables. Since the Adams consistometer is accurate to 0.25 Adams values, all values within 0.25 Adams values of one another will be interpreted, for all practical purposes, as being the same.

A. The consistency patterns of canned cream style sweet corn of the variety Deep Gold.

1. 1957 season.

The consistency patterns of the cream style corn packed during the 1957 season, shown in Chart II, indicated that the consistency changes

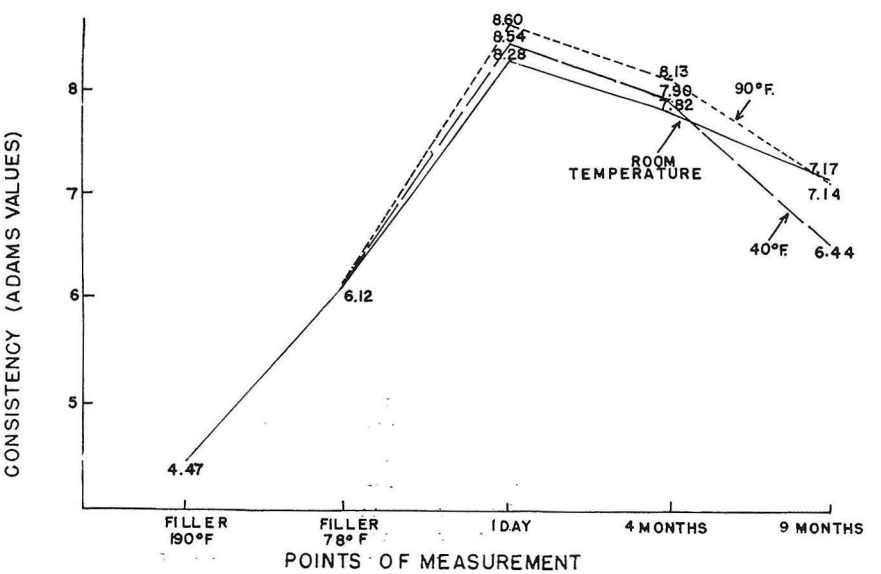


CHART II.—The effect of process, storage time, and storage temperature on the consistency of canned cream style sweet corn (1957 season).

which occurred in storage had the same general pattern at all three storage temperatures. The cream style corn reached its thickest consistency at a period between the time it was processed and four months storage. The samples showed an increase in consistency of 1.45 Adams values when the 190° F. filler samples were cooled to 78° F. The consistency values of the samples at all storage temperatures were within 0.75 Adams values of each other. A rapid deterioration of consistency occurred in the samples stored at 40° F. after four months of storage.

The variation from the general consistency pattern which occurred in some harvests may be explained by the fact that the maximum consistency of the corn samples from a few of the harvests were attained near the four-month storage period. Thus the four-month storage samples, rather than the one-day storage samples, had a higher Adams consistency value. Since the results show that this did occur in more harvests and to a larger degree in the samples stored at 90° F., it indicates that the cream style corn stored at this particular temperature "set up", or thickened at a slower rate than cream style corn stored at lower temperatures.

2. 1958 season.

The general consistency pattern for the cream style corn packed during the 1958 season is presented in Chart III. The consistency patterns varied slightly at different storage temperatures. The samples stored at 40° F. attained the thickest consistency while the 90° F. storage samples were slightly thinner at every storage period. The samples taken from the filler at 190° F. thickened in consistency approximately 1.75 Adams values upon cooling to 78° F. The samples stored at both room temperature and 90° F. exhibited a variation in consistency of less than 0.50 Adams values throughout the entire four-month storage period. The consistency of the 40° F. and 90° F. storage samples both showed a deterioration of the consistency after the ten week storage period, while the consistency of those samples stored at room temperature remained relatively stable.

Chart III shows that the maximum consistency of the 40° F. storage samples was attained sometime between six to ten weeks; from two weeks to ten weeks for the 90° F. storage samples, and from two weeks to 16 weeks for the samples stored at room temperature. However, a comparison of the consistency patterns of the different harvests indicates there were many variations from the general consistency pattern discussed above. These variations may be explained to some extent by the differences in formulations within harvests and will be discussed later.

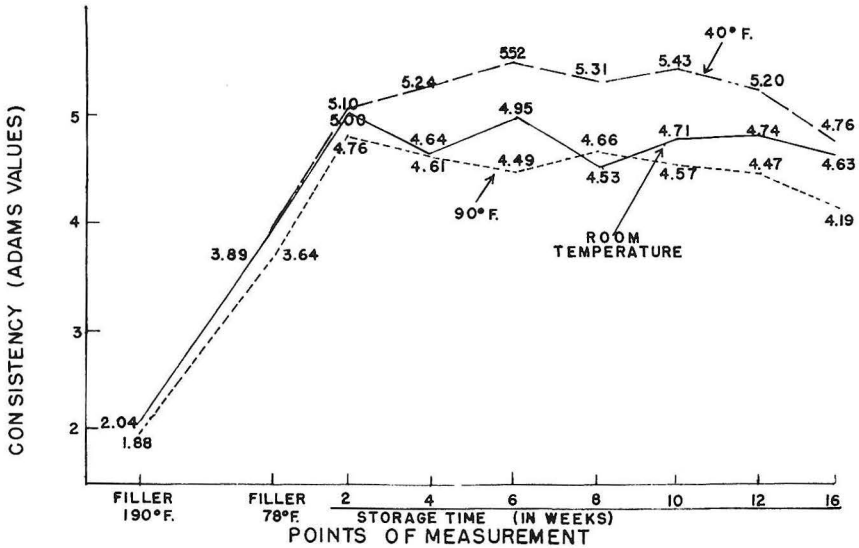


CHART III.—The effect of process, storage time, and storage temperature on the consistency of canned cream style sweet corn (1958 season).

Generally, regardless of the maturity, formulation, and storage temperature, the consistency of the corn reached its maximum consistency by the 4-month storage period and the consistency value at the 4-month storage period was lower or the same as the maximum consistency value, which was attained at an earlier storage period. These results are in agreement with the conclusions of Davis (3), Geidel (5), and Gabby (4) who noted that the maximum consistency of cream style corn was attained after a storage period extending from one week to two months.

A comparison of the consistency patterns of the 1957 and 1958 seasons is rather difficult because of the difference in the formulations and the storage times at which consistency measurements were made. However, it is possible to compare the results of both seasons at three sampling points; the filler at 190° F. and 78° F. and after four months storage. To evaluate this, samples containing no starch, 0.4 percent thin boiling starch, and 0.4 percent waxy maize starch of the 1957 season were compared to comparable samples from the 1958 season. For this comparison the consistency values at the filler (190° F.) were subtracted from the storage values, so the consistency values at the filler at 78° F. and at the different storages are actually a measure of the change

in consistency which occurred during storage. The results are presented in Table 5. Samples from both seasons had the same increase in consistency after the filler samples were cooled. After the four-months storage, however, the cream style corn from the 1957 season had a better (thicker) "setting-up" action than the corn from the 1958 season, but the consistency of the corn from the 1958 season was not affected by

TABLE 5.—Comparison of the change in consistency during storage of cream style sweet corn at three storage temperatures for two growing seasons

Season	Storage Temperature	Filler		Storage Time		
		190°	78°	4 Months	6 Months	9 Months
		Consistency Values*				
1957	40° F.	0	1.71	3.17	____	1.93
	Room Temp.	0	1.71	3.08	____	2.99
	90° F.	0	1.71	3.47	____	2.83
1958	40° F.	0	1.67	1.96	____	____
	Room Temp.	0	1.67	2.00	2.15	____
	90° F.	0	1.67	1.88	____	____

*The Adams Consistometer values at the filler at 190° F. were subtracted from the Adams Consistometer values at each point of measurement.

storage temperature. The consistency of the corn from the 1957 season stored at 90° F. had a decidedly thicker consistency, thus a better "setting-up" action, than the corn stored at 40° F. or room temperature.

Both of these variations can be explained by the fact that the corn from the 1957 season had a larger amount of inherent starch than the corn packed in the 1958 season. The Adams consistency values of the filler (190° F.) samples from the 1957 season averaged in the neighborhood of 4.65, while the average Adams consistency values of the hot filler samples from the 1958 season was approximately 0.80. This higher concentration of inherent starch occurring in the 1957 season could very well account for the increased consistency after four months storage and the differences in consistency which were noted at the different storage temperatures. However, there is one conclusion which can be drawn from this comparison that proves to be important in predicting the change in consistency which occurs during storage. That is, the thickening which occurred in the cooling of the hot filler samples had no rela-

tion to the change in consistency which occurred in storage, and therefore had no practical value and was an unnecessary consistency measurement in this variety of sweet corn.

The importance of seasonal variations on the consistency of the resulting cream style corn has been discussed by several investigators (4, 10, 12). Meister (12) stated that a serious problem faces the cream style corn canner in that he cannot keep the consistency of one year's pack like that of the year previous. A detailed study of the effect of seasonal variations on the consistency of cream style corn is beyond the scope of this study.

B. The maturity-added water relationship and its effect on the consistency.

The maturity of the raw corn and the amount of added water in the formulation are probably the two most important and most widely recognized factors affecting the consistency of cream style sweet corn. In the processing of cream style corn the amount of added water is dependent upon, and will vary with, the maturity of the corn. In the formulation of the cream style sweet corn for the 1958 season, the maturity-added water relationship was based on the specific gravity of the raw corn (Table 4). Both the maturity of the corn and the amount of added water affected the consistency of the corn in different ways. In general, the more mature the corn, the thicker the consistency, and the more water which was added, the thinner the consistency became. This, if course, is well known and is the basis of the maturity-added water relationship.

1. Maturity.

The effect of maturity on the consistency of cream style corn can be shown very effectively in two groups of samples taken from the 1957 season and the results are presented in Table 6. A comparison of the two groups of samples shows an alcohol insoluble solids variation of slightly over two percent, a moisture variation of less than four percent, and a specific gravity variation of 0.031 on the raw corn with the added water in the more mature samples almost three times that of the less mature samples. In spite of this large variation in water content the consistency of the more mature samples was comparable to that of the less mature samples. Even with the large amount of added water the increase in consistency during storage of the more mature corn was far superior to the change in consistency of the less mature corn samples with less added water, which is indicated in Table 6 by the average increase value.

TABLE 6.—The effect of raw corn maturity on the consistency of canned cream style sweet corn from the second planting at various room temperature storage periods (1957 season)

Harvest	Batch		Specific gravity	AIS (%)	Moist. (%)	Water (%)†	Filler		Storage time			Ave.* inc.
							190°	78°	1 Day	4 Mo.	9 Mo.	
							Consistency (Adams values)					
1	1		1.075	18.64	75.27	11.5	3.25	5.0	6.75	3.5	7.0	
	2					11.5	6.5	7.5	8.0	11.0	10.25	
	3					11.5	6.75	7.25	8.0	10.25	10.25	
	4					11.5	6.25	6.0	10.75	12.5	10.25	
		Mean					5.69	6.44	8.38	9.31	9.44	2.70
2	1		1.106	20.72	71.38	29.0	1.5	7.25	9.5	8.75	9.0	
	2					28.9	2.5	7.5	9.5	7.5	7.75	
	3					28.9	4.5	10.0	10.75	10.0	11.5	
	4					28.9	3.75	6.75	8.75	6.0	7.25	
		Mean					2.81	7.88	9.83	8.06	8.88	5.85

*Average increase was determined by averaging filler 78°, 1 Day, 4 Month, and 9 Month consistency measurements and from this subtracting the filler 190° consistency measurements.

†Percent water indicates the percentage water added in the formulation.

The samples from the two harvests also exhibited entirely different consistency patterns. The less mature corn samples attained their thickest consistency at the four-month and nine-month storage periods while the more mature samples had the thickest consistency after one day's storage, were thinner in consistency after four-months, then thickened considerably at the nine-month storage period. Thus, it became apparent that the maturity and/or added water had an effect not only on the changes occurring in consistency during storage, but on the consistency pattern as well.

2. Water

It is a logical deduction that, other factors being equal, an addition of water to cream style corn will decrease its consistency and the magnitude of the decrease will depend upon the amount of added water. This is shown very emphatically in Table 7, which represents the results of three harvests during the 1957 season. The consistency values of the cream style corn made from the first harvest of the first planting show that the consistency pattern did not change from one water concentration to another. The "average increase" value of 2.08 was attained in

TABLE 7.—The effect of water on the consistency of cream style corn at various room temperature storage periods (1957 season)

Planting	Harvest	Batch	Water (%)*	Filler		Storage time			Average increase†
				190° F.	78° F.	1 Day	4 Mo.	9 Mo.	
				Consistency (Adams values)					
1	1	1	15.7	4.25	6.5	7.75	7.75	6.0	
		2	15.6	6.75	8.5	7.75	6.75	10.5	
		3	15.6	6.5	8.75	9.75	8.5	7.25	
		4	15.6	6.75	8.0	11.5	8.0	7.0	
		Mean		6.06	7.94	9.19	7.75	7.69	2.08
		5	21.8	3.25	5.0	6.75	7.25	6.0	
		6	21.7	7.5	9.0	10.0	9.5	7.75	
		7	21.7	5.0	8.75	8.75	8.0	7.0	
		8	21.7	5.25	8.0	10.0	6.25	7.75	
		Mean		5.25	7.69	8.88	7.75	7.13	2.61
1	2	1	21.8	5.75	4.25	10.25	7.0	6.75	
		2	21.7	6.0	3.5	7.5	8.5	8.5	
		3	21.7	5.25	6.0	8.5	9.0	6.0	
		4	21.7	4.25	3.75	8.5	7.25	5.75	
		Mean		5.32	4.38	8.69	7.94	6.75	1.63
		5	15.7	7.75	8.5	13.75	10.25	12.0	
		6	15.6	8.5	9.75	11.25	11.25	10.5	
		7	15.6	8.0	10.5	11.75	13.25	11.5	
		8	15.6	7.25	8.75	10.5	8.0	8.75	
		Mean		7.88	9.38	11.81	10.69	10.69	2.76
2	1	1	11.5	3.25	5.0	6.75	3.5	7.0	
		2	11.5	6.5	7.5	8.0	11.0	10.25	
		3	11.5	6.75	7.25	8.0	10.25	10.25	
		4	11.5	6.25	6.0	10.75	12.5	10.25	
		Mean		5.69	6.44	8.38	9.31	9.44	2.70
		5	18.2	0.5	2.75	3.75	5.5	4.25	
		6	18.1	3.5	2.75	5.5	6.5	8.25	
		7	18.1	2.25	3.75	4.75	7.0	6.75	
		8	18.1	1.5	2.5	3.5	6.75	4.0	
		Mean		1.94	2.94	4.38	6.44	5.81	2.95

*Percent water indicates the percentage water added in the formulation.

†Average increase was determined by averaging filler 78°, 1 day, 4 month, and 9 month consistency measurements and from this subtracting the filler 190° consistency values.

the samples with the lower water concentration while the samples with a higher water concentration exhibited a 2.61 "average increase" value, indicating that the consistency during storage was more efficient in the samples which contained the higher concentration of water. The results of this harvest also show that the samples containing the higher water concentraton attained the same Adams Consistency values at the one-day and four-month storage periods as did the samples with the lower water concentration. The series of samples from the second harvest of the first planting produced results which would normally be expected, that is, no change in the consistency pattern with the samples from the low water concentration exhibiting distinctly higher consistency values.

There are other important aspects to be pointed out when comparing the results of each of the harvests. In each of the three series of data in Table 7 the consistency values of the samples containing the low water additions were almost the same at the nine-month storage period as they were at the four-month storage period, whereas in the samples with the higher water concentration the consistency was at least 0.50 Adams values lower at the nine-month storage period than at the four-month storage period. Apparently the more water which was added in the formulation, the faster the decrease in consistency after a maximum value had been attained. It is also quite possible that the amount of added water influenced the time in storage required to reach the maximum consistency, as evidenced by the samples containing the lower water concentration from the first harvest of the second planting which apparently had not reached the maximum consistency value even after nine months of storage. This observation can explain, to some extent at least, why different harvests and different formulations of cream style corn exhibited different consistency patterns.

The "average increase" value, or efficiency of "setting up" during storage, instead of decreasing as the amount of added water was increased, apparently increased to an optimum, then as more water was added the efficiency of "setting up" decreased as evidenced by the first harvest of the first planting and the first harvest of the second planting where the samples containing the higher water concentration produced the highest "average increase". This efficiency of "setting up" was not dependent upon the consistency of the corn. The highest "average increase" value was obtained in samples whose thickest average consistency was 6.44, which would be considered slightly thin for "Fancy" consistency, and the next highest "average increase" value was obtained

from samples of corn whose thickest average consistency was 11.81, which would be considered too thick for "Fancy" consistency.

C. Added starch as a factor affecting the consistency.

The starch which is added to cream style corn in the formulation is an optional ingredient. Many cream style corn canners do not use starch. The Food and Drug Administration states in the Standards of Identity for Canned Cream Style Corn that starch may be used, and if it is used it must so be stated on the label (18). The amount and type of starch to use, however, has been left up to the discretion of the processor. Starch may involve two factors which will affect the consistency of cream style corn, the amount of starch and the type of starch added in the formulation. In this study a control and three types of starch at three different concentrations were included.

1. Amount of added starch.

An analysis of variance was performed on corn samples from the 1958 season. This analysis involved the consistency of the control (no added starch) samples and samples containing waxy maize starch in concentrations of 0.4 percent, 1.0 percent, and 1.4 percent, stored at temperatures of 40°, room temperature, and 90°, and measured at time intervals of 2, 4, 6, 8, 10, 12, and 16 weeks. The results of this analysis are presented in Table 8 and show that the starch content had a highly significant effect on the resulting consistency, while the storage time had a significant effect and the effect of the storage temperature was not significant. The interactions indicated that there was a highly significant interaction between the starch and the storage temperature and a significant interaction between the storage time and the storage temperature.

Chart IV shows graphically the interaction which occurred between the starch content and the storage temperature and also the highly significant increase in consistency which occurred as the starch content was increased with the storage temperature apparently having no effect on this increase. In fact, in some samples of corn it was noted that the control batch was so thin it would be rated Substandard grade (Adams value of 0-2.00) and the batch containing an addition of 1.4 percent starch increased the consistency to a point where it would be rated as Standard grade because of the consistency being too thick. (Adams value of 12.00 - 14.00).

Charts V, VI, and VII also show the rather spectacular increase in consistency which occurred as the percentage of added starch was increased. A comparison of the three charts shows that the type of

TABLE 8.—Analysis of variance of the consistency of canned cream style sweet corn (1958 season)

Source	Σ Squares	df	MS	F
Total	40404362	420		
Main Effects				
Harvest	3784325	4	946081	
Starch	32310088	3	10770029	83.3483†
Temperature	64081	2	32041	.6851n.s.
Time	110664	6	18444	3.3419
Main Effect Errors				
S × H	1550604	12	129217	
Te × H	374103	8	46763	
Ti × H	132446	24	5519	
1st order interactions				
S × Te	245050	6	40842	3.7234†
S × Ti	85527	18	4752	.7822n.s.
Te × Ti	121523	12	10127	1.9675*
1st order interaction errors				
S × Te × H	263254	24	10969	
S × Ti × H	437375	72	6075	
Te × Ti × H	247064	48	5147	
2nd order interactions				
S × Te × Ti	148929	36	4137	1.1331n.s.
2nd order interaction error				
S × Te × Ti × H	529329	145	3651	

*Significant at 5 percent level.
†Significant at 1 percent level.

added starch and the storage temperature had only a minor influence on the consistency increase at each of the starch concentrations. Generally, an addition of starch amounting to about 0.4 percent caused an increase in consistency amounting to about 0.5 to 1.5 Adams values: An addition of starch amounting to 1.00 percent increased the consistency from 3.25 to 4.25 Adams values over those values of the samples containing no starch: while the addition of starch amounting to 1.4 percent caused a consistency increase of 5.5 to 7.0 Adams values over those samples in which there was no added starch. When the amount

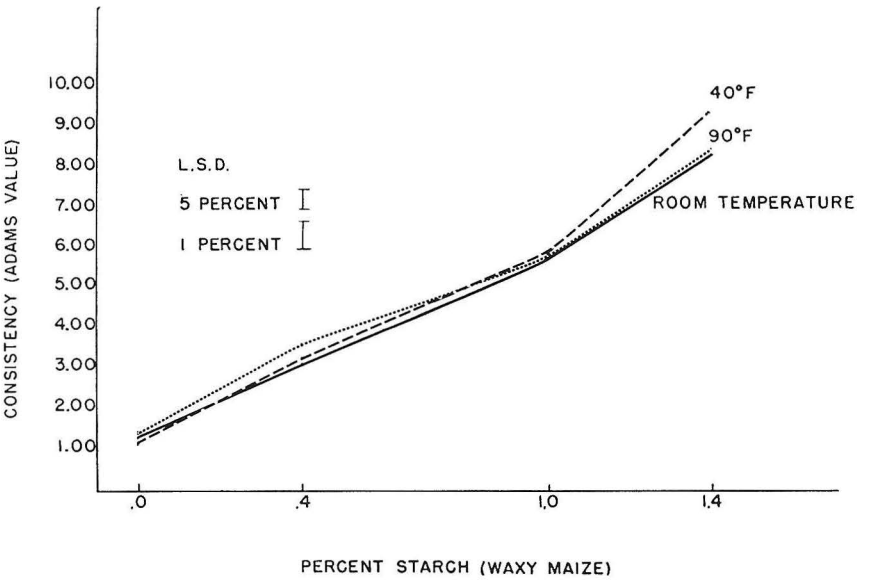


CHART IV.—Average consistency values of canned cream style sweet corn containing several concentrations of waxy maize starch and stored at three storage temperatures (1958 season).

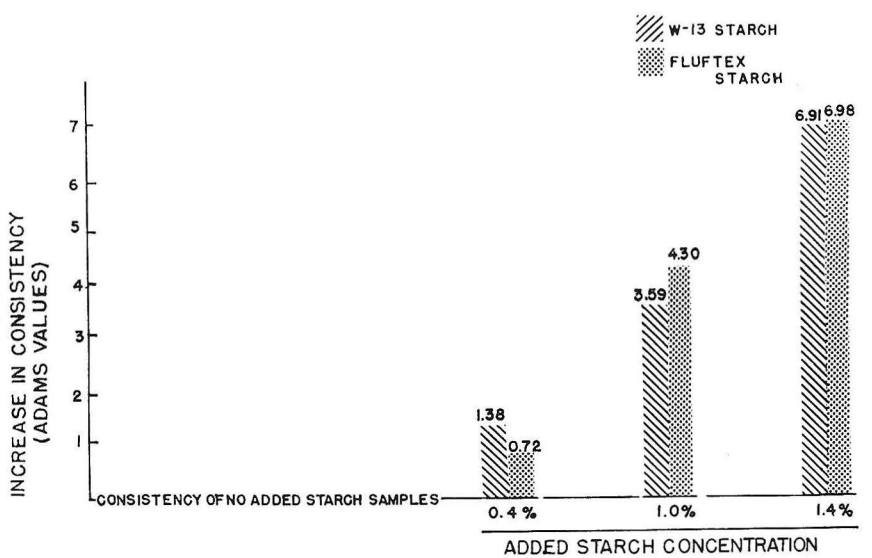


CHART V.—The effect of added starch on the consistency of canned cream style sweet corn stored at 40° F. for 4 months (1958 season).

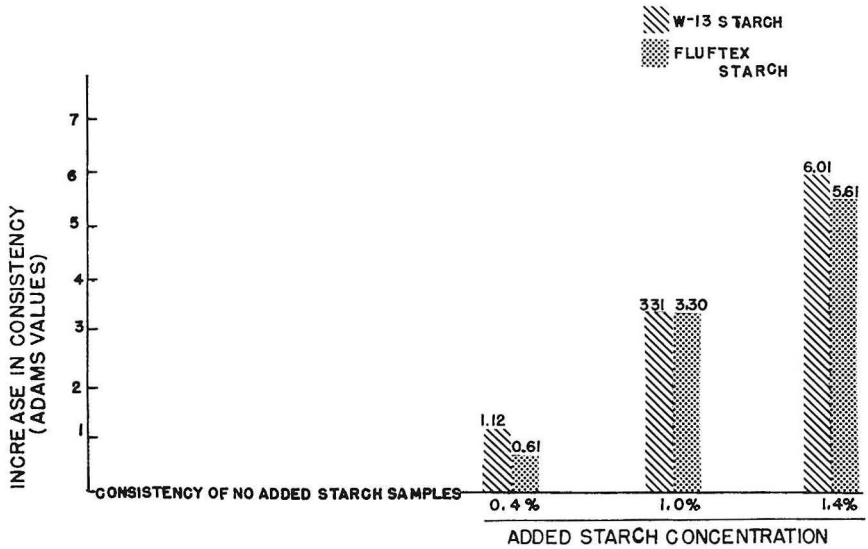


CHART VI.—The effect of added starch on the consistency of canned cream style sweet corn stored at room temperature for 4 months (1958 season).

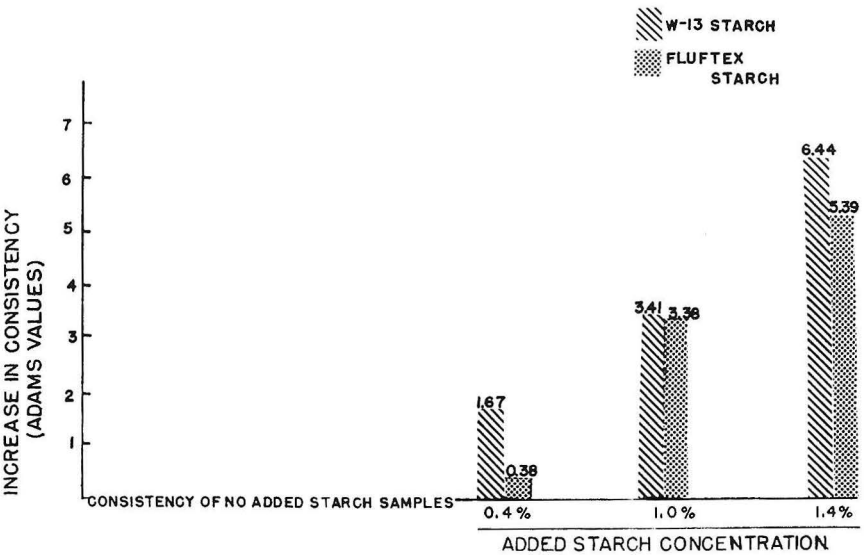


CHART VII.—The effect of added starch on the consistency of canned cream style sweet corn stored at 90° F. for 4 months (1958 season).

of added starch is compared to the other factors affecting the consistency, such as maturity, starch type, and storage temperature, the results of this study show that this factor is by far the greatest influence on the consistency of the cream style corn.

2. Type of added starch.

The type of starch which is added in the formulation was probably not as important as some of the other factors discussed but it must be considered because of its variable effect on the consistency which is related to the maturity, storage temperature, and retrogradation of the starch during storage.

An analysis of variance was performed on the corn samples from the 1957 season. This analysis involved the consistency data of the control samples and samples containing a 0.4 percent concentration of a thin boiling linear starch (Fluftex), a waxy maize starch (W-13), and a thick boiling linear starch (Purity NCS). The samples involved were stored at temperatures of 40°, room temperature, and 90°, and measured for consistency after storage periods of 1 day, 4 months, and 9 months. The results of this analysis are presented in Table 9 and show that the storage time had a highly significant effect on the resulting consistency, the starch content had a significant effect, and the storage temperature was not significant. The interaction between the storage time and the storage temperature was highly significant and the interaction between the starch content and the storage temperature was significant. Thus, when employed in small concentrations the starch type was not as important as some other factors, such as the storage time, when considering its effect on the actual consistency as determined by the distance of flow of the cream style corn.

There are, however, some very distinct differences in the consistency values of cream style corn made from the different types of starch. Table 10 shows the average consistency values of the no added starch samples and the samples containing additions of 0.4 percent starch of three different types and stored at three storage temperatures. This table shows that the samples containing no added starch were thinner in consistency than the added starch samples regardless of the storage temperature. Furthermore, the samples containing the thick boiling linear starch had the thinnest consistency of the added starch samples at all three storage temperatures. The samples containing the waxy maize starch and the thin boiling linear starch showed the greatest over all increase in consistency. The variation in consistency between storage

TABLE 9.—Analysis of variance of the consistency of canned cream style sweet corn (1957 season)

ANALYSIS OF VARIANCE

Source	Σ Squares	df	MS	F
Total	25603625	323		
Main Effects				
Harvest	17619444	8	2202430	
Starch	1017692	3	339231	5.268*
Temperature	195914	2	97957	3.336n.s.
Time	816701	2	408351	6.785†
Main Effect Errors				
S × H	1545572	24	64399	
Te × H	469850	16	29366	
Ti × H	962918	16	60182	
1st order interactions				
S × Te	266741	6	44457	3.121*
S × Ti	87528	6	14588	1.420n.s.
Te × Ti	229260	4	57315	7.506†
1st order interaction errors				
S × Te × H	683745	48	14245	
S × Ti × H	493270	48	10276	
Te × Ti × H	244351	32	7636	
2nd order interactions				
S × Te × Ti	117344	12	9779	1.100n.s.
2nd order interaction error				
S × Te × Ti × H	853295	96	8888	

*Significant at 5 percent level.
†Significant at 1 percent level.

temperatures was most uniform in the no added starch samples, which changed less than 0.25 Adams values, and greatest in the samples containing the thick boiling linear starch, which had a consistency variation of almost 0.75 Adams values. The variation in consistency between storage temperatures in the thin boiling linear starch samples was also notably lower than in the samples containing the waxy maize starch.

In the 1958 season only the thin boiling linear starch and the waxy maize starch types were used, but their concentration was increased to include a control (no added starch), 0.4 percent, 1.0 percent, and 1.4 percent by weight of added starch. A comparison of the effect of these two starch types on the consistency of the cream style corn are shown in Charts V, VI, and VII and on Table 11. Charts V, VI, and VII show that regardless of storage temperature, the starch type did not have nearly the pronounced effect on the consistency as did the starch concentration and although some slight differences in consistency were noted, these differences were minor ones.

Table 11 shows the average consistency values in cream style corn of the various starch treatments after four months storage at temperatures of 40° F., room temperature, and 90° F. The results obtained during both seasons were similar in that the consistency of the sample containing no added starch was lower than the consistency of the samples to which starch was added, regardless of the storage temperature. Further, as the storage temperature was increased the actual increase in consistency during storage decreased in the samples containing the added thin boiling linear starch, regardless of the concentration. Generally, in the samples containing the added waxy maize starch the highest consistency values were obtained at storage temperature of 40° F. and 90° F. The concentration of waxy maize starch also had an effect on the change in consistency during storage, since the samples containing 0.4 percent waxy maize starch had its greatest increase in consistency when stored at 90° F., while those samples containing 1.4 percent waxy maize starch had the greatest increase in consistency when stored at 40° F.

Normally, the cream style corn canner cannot be assured that his product will be stored where there would be no temperature fluctuation. Thus, the portions of Tables 10 and 11 showing the variations in consistency between storage temperatures becomes a very important factor for consideration. In the 1957 season the corn samples containing no starch apparently were least affected by the storage temperature. At a concentraton of 0.4 percent starch, the three starch types had a consistency variation of 0.25-0.50 Adams values between storage temperatures. These results are verified by the results obtained from the corn packed during the 1958 season. However, as the added starch concentration was increased, this variation in consistency between storage temperatures did not change when the added starch was of the waxy maize type, but as the concentration of the thin boiling linear starch was increased

TABLE 10.—Average consistency values of cream style corn containing various starch treatments and stored at various storage temperatures (1957 season)

Storage Temperature	Starch Treatment	Average Consistency (Adams) Value	Difference*
40° F.	No Starch	5.87	----
	0.4 % Thin Boiling Linear (Fluftex)	7.63	1.76
	0.4 % Waxy Maize (W-13 Stabilizer)	6.91	1.04
	0.4 % Thick Boiling Linear (Purity NCS)	6.28	0.41
Room Temperature	No Starch	5.86	----
	0.4 % Thin Boiling Linear (Fluftex)	7.25	1.39
	0.4 % Waxy Maize (W-13 Stabilizer)	7.53	1.67
	0.4 % Thick Boiling Linear (Purity NCS)	6.75	0.89
90° F.	No Starch	5.97	----
	0.4 % Thin Boiling Linear (Fluftex)	7.54	1.57
	0.4 % Waxy Maize (W-13 Stabilizer)	7.57	1.60
	0.4 % Thick Boiling Linear (Purity NCS)	6.97	1.00

Starch Treatment	Maximum Variation Between Storage Temperature (Adams Values)
No Starch	0.11
0.4 % Thin Boiling Linear (Fluftex)	0.38
0.4 % Waxy Maize (W-13 Stabilizer)	0.66
0.4 % Thick Boiling Linear (Purity NCS)	0.69

*Difference is the average consistency value of the starch treatment minus the average consistency value of the no starch treatment.

the variation in the consistency between the storage temperatures increased greatly. This must be considered an important factor which can be controlled by the type of added starch and it is obvious that the waxy maize type of starch would be preferred over a thin boiling linear starch.

When determining the grade in cream style corn the factor of consistency includes not only the thickness but also the creaminess and liquor separation, or weeping. The waxy maize type starch has the ability to resist weeping, which is caused by the retrogradation of the starch. This property is lacking in all linear corn starches. The effect

TABLE 11.—Average consistency values of cream style corn containing various starch treatments and stored at various storage temperatures (1958 season)

Storage Temperature	Starch Treatment	Average Consistency (Adams) Value	Difference*
40° F.	No Starch	1.47	----
	0.4 % Thin Boiling Linear (Fluftex)	2.19	0.72
	0.4 % Waxy Maize (W-13 Stabilizer)	2.85	1.38
	1.0 % Thin Boiling Linear (Fluftex)	5.77	4.30
	1.0 % Waxy Maize (W-13 Stabilizer)	5.06	3.59
	1.4 % Thin Boiling Linear (Fluftex)	8.45	6.98
	1.4 % Waxy Maize (W-13 Stabilizer)	8.38	6.91
Room Temperature	No Starch	1.87	----
	0.4 % Thin Boiling Linear (Fluftex)	2.66	0.79
	0.4 % Waxy Maize (W-13 Stabilizer)	3.14	1.27
	1.0 % Thin Boiling Linear (Fluftex)	5.21	3.34
	1.0 % Waxy Maize (W-13 Stabilizer)	5.46	3.59
	1.4 % Thin Boiling Linear (Fluftex)	7.55	5.68
	1.4 % Waxy Maize (W-13 Stabilizer)	8.04	6.17
90° F.	No Starch	1.50	----
	0.4 % Thin Boiling Linear (Fluftex)	1.88	0.38
	0.4 % Waxy Maize (W-13 Stabilizer)	3.17	1.67
	1.0 % Thin Boiling Linear (Fluftex)	4.88	3.38
	1.0 % Waxy Maize (W-13 Stabilizer)	4.91	3.41
	1.4 % Thin Boiling Linear (Fluftex)	6.89	5.39
	1.4 % Waxy Maize (W-13 Stabilizer)	7.94	6.44

Maximum variation in consistency between storage temperatures:

	Adams Value
No Starch	0.37
0.4 % Thin Boiling Linear Starch (Fluftex)	0.78
0.4 % Waxy Maize Starch (W-13 Stabilizer)	0.32
1.0 % Thin Boiling Linear Starch (Fluftex)	0.89
1.0 % Waxy Maize Starch (W-13 Stabilizer)	0.55
1.4 % Thin Boiling Linear Starch (Fluftex)	1.56
1.4 % Waxy Maize Starch (W-13 Stabilizer)	0.44

*Difference is the average consistency value of the starch treatment minus the average consistency value of the no starch treatment.

of retrogradation on the appearance of cream style corn was quite noticeable. Figure 6 shows two samples of unstirred cream style corn from the same harvest with one sample containing a 1.0 percent concentration of the linear type starch and the other sample containing a 1.0 percent concentration of a waxy maize type starch. The sample containing the linear starch appeared watery and contained a starchy mass which had separated from the kernels, while the sample containing the waxy maize starch appeared smooth, creamy, and appetizing. Figure 7 shows the same samples after they had been stirred and it can be noted that both appeared to be creamy, smooth, and appetizing. Figure 8 shows two samples of cream style corn from the same harvest and containing a 1.0 percent linear starch. One of the samples had been shaken to show the reversibility of the retrogradation phenomena and the change in the appearance of the cream style corn.

The ability of the waxy maize starch to not only resist retrogradation, but to protect the inherent linear starch from retrogradation made possible a product which did not have to be stirred before the quality is evaluated. Although the retrogradation itself is not considered a factor in determining the quality of cream style corn, its degradational effects are realized by the industry. The Food and Drug Administration in the Standards of Identity, Quality, and Fill of Containers for canned cream style sweet corn specify that the cream style corn be mixed before the consistency determination (18). Many cream style corn canners have adopted as standard procedure the mechanical shaking of each can of cream style corn immediately before it is shipped out to be sold on the retail market. The use of a waxy maize type starch in the formulation would eliminate this operation, and further, the housewife, upon opening the can, would see a smooth, appetizing product rather than a watery, starchy mass which is common in cream style corn where retrogradation has occurred. The acceptance and use of a waxy maize type of added starch could also eliminate the procedure of shaking the can of cream style corn before grading, thus eliminating any changes in the consistency which occurs in the shaking operation.

D. Storage temperature and time and their effect on the consistency.

Storage temperature, although shown to have no significant effect on the consistency of either the 1957 or 1958 corn samples (Tables 8 and 9) nevertheless appeared to be an important factor for consideration because of its apparent direct affect on the type of added starch. This may well be one of the reasons why cream style corn made from some

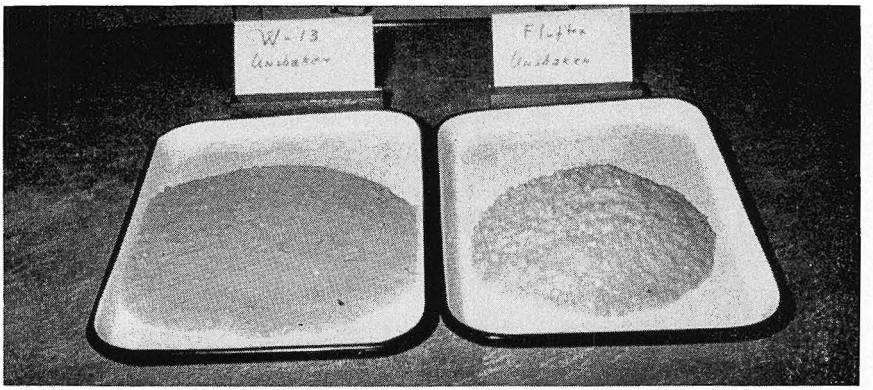


Fig. 6.—Two samples of unstirred corn from the same harvest.

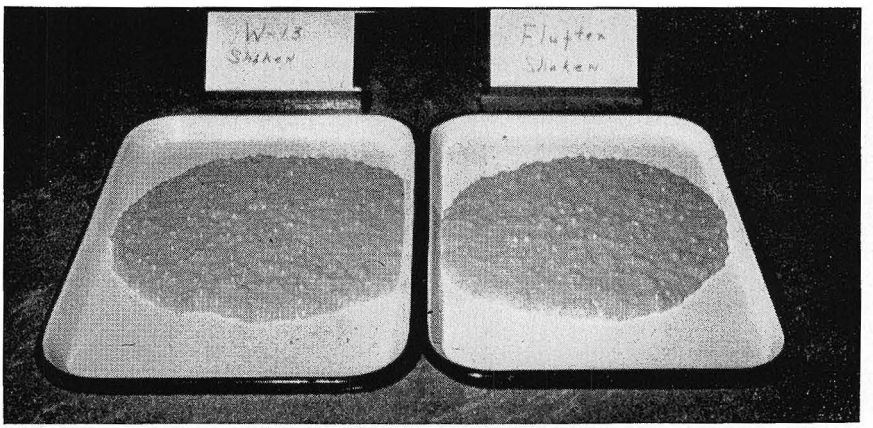


Fig.7—Both samples have been stirred in this photograph.

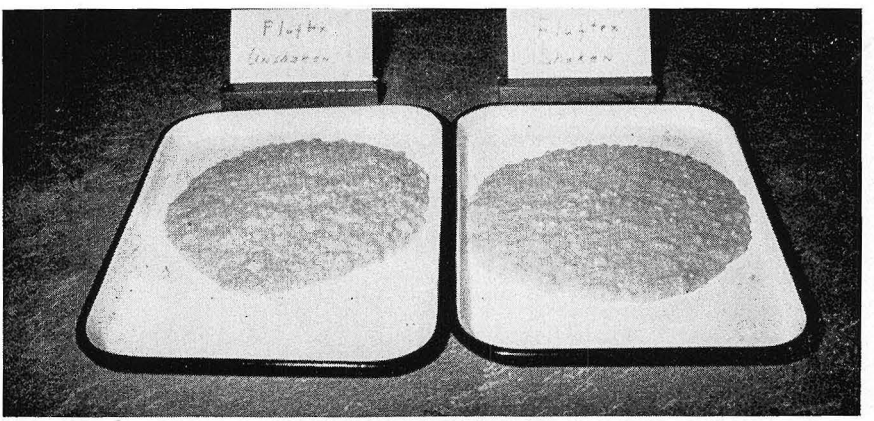


Fig. 8.—Sample on the left has not been stirred.

harvests were different in their consistency characteristics. The room temperature storage samples appeared to have the least variable consistency in that the samples did not increase nor decrease in consistency during storage to the magnitude shown by the 40° F. and 90° F. storage samples. In the 1958 season the 40° F. storage samples had the best increase in consistency during storage, as shown in Chart III. However, in the 1957 season the 40° F. storage samples displayed consistency values which were less than those samples stored at 90° F., and, as shown in Chart II, at the nine-month storage period showed a considerable decrease in consistency. This peculiar storage behavior from one season to another can be practically, if not entirely, explained by the difference in starch treatments. The thick boiling linear starch was not used in the 1958 pack. When used in the 1957 season it produced samples having the poorest increase in consistency during storage of the three types of starches as shown in Table 10. This, combined with the fact that its poorest consistency occurred in the 40° F. samples, may have been enough to decrease the 40° F. average consistency values to a point where it displayed the pattern shown in the 1957 season on Chart II.

The cream style corn samples did show some susceptibility to a difference in storage temperature. As shown in Tables 10 and 11 the samples containing no starch maintained the same average consistency values regardless of the storage temperature in the 1957 season, yet in the 1958 season the samples stored at room temperature had a slightly thicker average consistency than those samples stored at 40° F. and 90° F. This variation, however, could be caused by the longer storage time and more sampling points which were included in the room temperature storage treatments. The results given in Table 10 indicate that the waxy maize starch and the thick boiling linear starch treatments reacted the same in that the average consistency values in the 40° F. storage samples did not attain as thick a consistency as the room temperature and 90° F. storage samples. The waxy maize starch samples, however, had the thickest consistency at both the 90° F. and room temperature storages while the thick boiling linear starch samples had the poorest increase in consistency during storage of the three starch types. Since the thin boiling linear starch samples displayed a thin consistency at the room temperature storage, the waxy maize starch would appear to be the better of the three starches for use in cream style corn. A comparison of the waxy starch and the thin boiling linear starch treatments at various concentrations and temperatures is given in Table 11. Only in the 1.0 percent waxy maize starch treatments were the average consist-

ency values the same in relation to the average consistency values of the no starch samples at all three storage temperatures. Also, as shown in Chart IV, an increase in the waxy maize starch from 1.0 percent to 1.4 percent caused a larger increase in consistency in the samples stored at 40° F. than those samples stored at room temperature and 90° F., thus indicating the interaction which occurred between the starch concentration and the 40° F. storage temperature. These results show that generally the 1.0 percent waxy maize starch concentration was superior to the 0.4 percent and the 1.4 percent concentrations, and also would be preferred over all concentrations of the linear starch.

The storage time was shown to have a highly significant effect on the consistency of cream style corn when the samples were measured periodically over a nine-month storage period during the 1957 season (Table 9) and have a significant effect when measured periodically over a four-month storage period during the 1958 season (Table 8). Further, the interaction between the storage time and the storage temperature followed this same pattern in that the interaction was highly significant in the corn samples measured periodically over a nine-month storage period and significant in those samples measured periodically over a four-month storage period. Charts VIII and IX show graphically the interaction between the storage time and the storage temperature, Chart VIII over a four-month storage period and Chart IX over a nine-month storage period. Both charts show that there is no significant

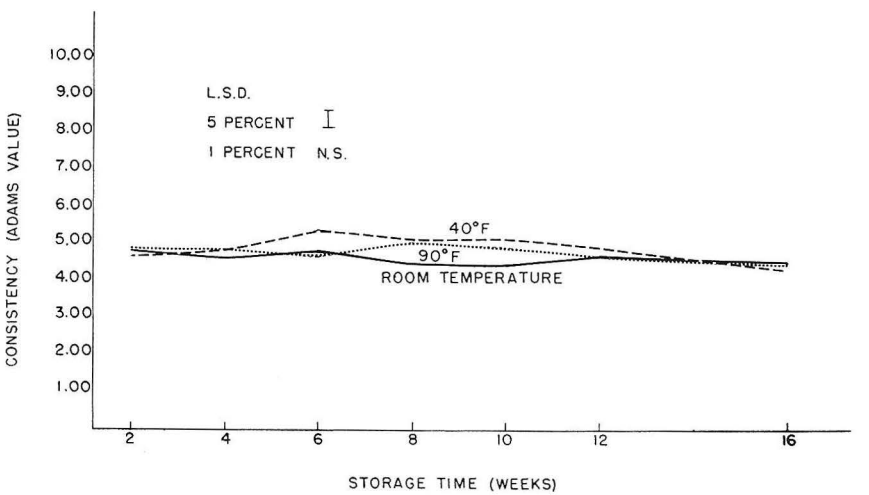


CHART VIII.—Average consistency values of canned cream style sweet corn stored at three different storage temperatures and measured at various storage periods (1958 season).

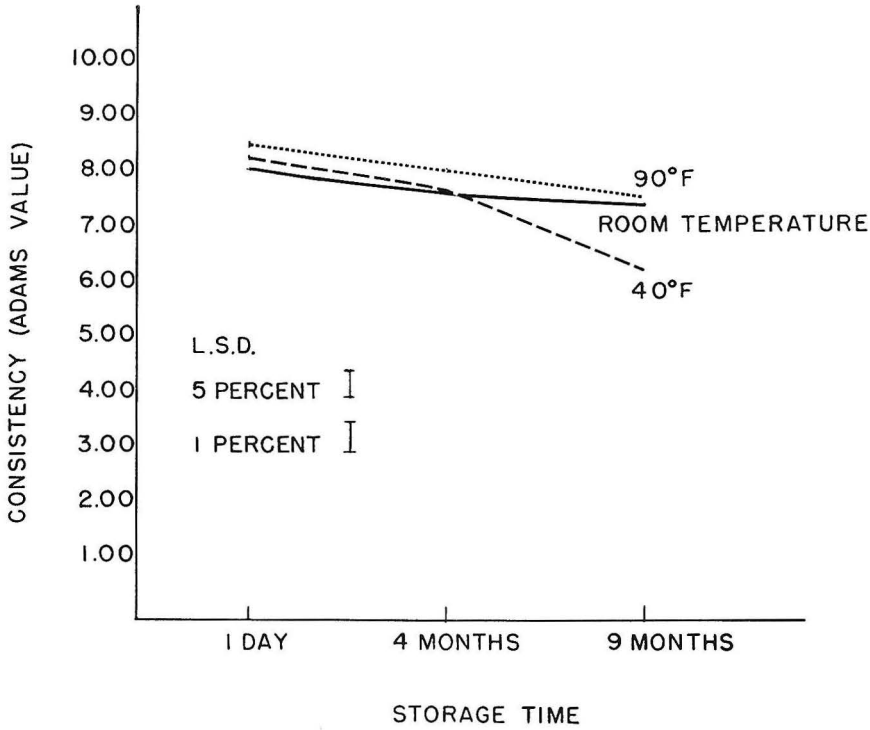


CHART IX.—Average consistency values of canned cream style sweet corn stored at three different storage temperatures and measured at various storage periods (1957 season).

difference in the consistency of the 40°, room temperature, and 90° storage samples at either the first measuring period or after a four-month storage period. Chart IX shows further that there is no significant difference in consistency between the room temperature and 90° storage samples after nine months of storage, but the samples stored at 40° for nine months had thinner consistency values which were highly significant from the consistency values of the room temperature or 90° storage samples. The corn samples stored at 40°, therefore, experienced a degradation of consistency between the four-month and the nine-month storage period. This degradation which occurred after prolonged storage at 40° plus the resulting poor quality (color and flavor) of corn stored at 90° indicates that room temperature storage would definitely be the preferred storage temperature.

PRACTICAL APPLICATION OF THE FINDINGS

Based on the data and results obtained in this study, it is believed that the corn processor can be assured of high quality, uniform consistency cream style corn by understanding the effects and interrelationships of the more important factors which determine the consistency. The most desirable variety for use in cream style corn would be one like Deep Gold which contains a type of starch which has the potential of "setting up" rapidly to a thick consistency and maintaining this consistency over a long storage period, even when present only in small quantities. These characteristics would enable a processor to harvest tender, immature corn and still add sufficient water to obtain good recovery. The consistency pattern of the cream style corn should be only slightly effected by other factors, such as maturity, seasonal variations, storage temperature, and the type of added starch.

The maturity of the sweet corn at the time of harvest should be the only variable which would have a direct effect on the consistency of the finished product. This variable would be controlled by the amount of water which would be added in the formulation. A maturity-water relationship should be established, based on quick objective maturity tests of the raw sweet corn. Thus, the amount of water to be added to each batch would be predetermined and dependent upon the maturity of the sweet corn.

Starch should be added to every batch of cream style corn, regardless of the maturity of the corn. The added starch will decrease syneresis and will give a smooth, creamy product. The amount of starch to add will vary with the starch type and would be limited by the development of a starchy flavor. The amount of added starch should be kept constant throughout the entire pack, regardless of the maturity of the corn. The added starch should be of the waxy maize type, such as W-13, since this type of starch not only resists retrogradation but a variation in the storage temperature will cause only a minor consistency change. 1.0 percent by weight of a waxy maize type starch should be added when using the variety Deep Gold.

The storage time would, of course, depend upon the market conditions. Since many investigators (3, 4, 13) have reported that the consistency of canned cream style corn reaches a maximum at some period during storage, then begins to decrease steadily as the storage time is extended, the choice of the correct maturity-water relationship and starch concentration will insure that this maximum consistency

value will be maintained over a longer period of time. The conception of allowing corn of thin consistency to remain in storage for a long period of time to thicken is a false assumption, as shown by the consistency patterns obtained in this study.

If the proper maturity-water relationship, starch type, and starch concentration are realized in the formulation, then the storage temperature will have very little effect on the consistency. However, the room temperature storage is preferred since the cooler storage temperature (40° F.) will increase the retrogradation of the starch and also decrease the effectiveness of the waxy maize starch for resisting retrogradation, while the corn stored at the higher temperature (90° F.) showed a rapid degradation of color after three months storage.

SUMMARY AND CONCLUSIONS

In this study some of the more important factors believed to affect the consistency of cream style corn were evaluated. The nature of the consistency change during storage was evaluated. The relationships between corn maturity and added water as well as the concentration of added starch was studied. Three starch types were used in the formulation and their affects on the consistency were evaluated in relation to the maturity of the sweet corn. Finally, the canned cream style corn was subjected to three storage temperatures, and the temperature effects on the consistency were likewise evaluated in relation to maturity and starch type. The study was further enhanced by increasing the concentration of the thin boiling linear starch and the waxy maize starch used in the formulation. The resulting cream style corn was stored at three temperatures (40° F., room temperature, and 90° F.) and the storage time between consistency determinations was decreased. The results were evaluated in relationship to starch type, amount of starch, and storage temperature. The major conclusions are summarized as follows:

1. The increase in consistency which occurred when samples taken from the filler before processing and cooled from 190° F. to 78° F. cannot be used as an indicator to predict the magnitude of the change in consistency which occurs during storage.

2. The amount of added starch was more important than the type of added starch or the storage temperature as a factor affecting the consistency or spread of the cream style corn as measured with the Adams Consistometer.

3. The cream style corn samples with no added starch had significantly lower Adams consistency values than the corn samples containing added starch, regardless of the storage time or storage temperature.

4. The addition of a thick boiling starch, in general, produced a thinner cream style corn than the other starch types regardless of the storage temperature.

5. The cream style corn samples containing the waxy maize starch generally had only minor consistency changes from one storage temperature to another. The 0.4 percent and 1.0 percent starch concentrations gave the best results in this respect.

6. Retrogradation of the cream style corn was not a problem in the samples containing the waxy maize starch. The resulting cream style corn was smooth, creamy, and appetizing, and with no water separation. The corn containing no added starch or linear starch was a starchy, watery, and unappetizing product unless it was stirred or shaken thoroughly to overcome the retrogradation effect.

7. In the manufacture of cream style corn the following practices would be recommended based on the results of this study:

a. The maturity of the raw sweet corn can be used to determine the amount of water added in the formulation. This can be done by comparing the results of quick maturity tests with the amount of water added to obtain the desired consistency over several seasons, then developing maturity classifications into which a specified amount of water is designated.

b. The amount of water to add to each batch of cream style corn should be pre-determined before the batch is mixed and will depend upon the maturity of the raw corn.

c. A waxy maize type of starch should be added in the formulation of the cream style corn. The amount of added starch should be kept constant, regardless of the maturity of the corn.

d. Fluctuations in the storage temperatures (40° F. to 90° F.) will have a minor, if any, effect on the resulting consistency of the cream style corn.

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APPENDIX TABLE A. Specific gravity, percentage alcohol insoluble solids (AIS), moisture, and formulation of raw sweet corn of the variety Deep Gold (1957 season).

Planting	Harvest	Batch	Spec. Grav.[1]	AIS (%)[1]	Moist. (%)[1]	FORMULATIONS					
						Corn (%)	Salt (%)	Sugar (%)	Water (%)	Starch (%)	Starch type
1	1	1	–	18.46	72.66	78.3	0.5	5.5	15.7	0.	
		2	–	–	–	78.0	0.5	5.5	15.6	0.4	Thin boiling
		3	–	–	–	78.0	0.5	5.5	15.6	0.4	Waxy-maize
		4	–	–	–	78.0	0.5	5.5	15.6	0.4	Thick boiling
		5	–	–	–	72.6	0.5	5.1	21.8	0.	
		6	–	–	–	72.3	0.5	5.1	21.7	0.4	Thin boiling
		7	–	–	–	72.3	0.5	5.1	21.7	0.4	Waxy-maize
		8	–	–	–	72.3	0.5	5.1	21.7	0.4	Thick boiling
		9	–	–	–	78.3	0.5	5.5	15.7	0.	
1	2	1	1.095	21.06	71.82	72.6	0.5	5.1	21.8	0.	
		2	–	–	–	72.3	0.5	5.1	21.7	0.4	Thin boiling
		3	–	–	–	72.3	0.5	5.1	21.7	0.4	Waxy-maize
		4	–	–	–	72.3	0.5	5.1	21.7	0.4	Thick boiling
		5	–	–	–	78.3	0.5	5.5	15.7	0.	
		6	–	–	–	78.0	0.5	5.5	15.6	0.4	Thin boiling
		7	–	–	–	78.0	0.5	5.5	15.6	0.4	Waxy-maize
		8	–	–	–	78.0	0.5	5.5	15.6	0.4	Thick boiling
		9	–	–	–	72.6	0.5	5.1	21.8	0.	
2	1	1	1.075	16.25	75.27	82.2	0.6	5.6	11.5	0.	
		2	–	–	–	81.8	0.6	5.7	11.5	0.4	Thin boiling
		3	–	–	–	81.8	0.6	5.7	11.5	0.4	Waxy-maize
		4	–	–	–	81.8	0.6	5.7	11.5	0.4	Thick boiling
		5	–	–	–	75.9	0.5	5.3	18.2	0.	
		6	–	–	–	75.6	0.5	5.3	18.1	0.4	Thin boiling
		7	–	–	–	75.6	0.5	5.3	18.1	0.4	Waxy-maize
		8	–	–	–	75.6	0.5	5.3	18.1	0.4	Thick boiling

[1] *The specific gravity, AIS and moisture were determined on a representative sample of each harvest.*

APPENDIX TABLE A.–Continued–Specific gravity, percentage alcohol insoluble solids (AIS), moisture, and formulation of raw sweet corn of the variety Deep Gold (1957 season).

Planting	Harvest	Batch	Spec. Grav.[1]	AIS (%)[1]	Moist. (%)[1]	FORMULATIONS Cprn (%)	Salt (%)	Sugar (%)	Water (%)	Starch (%)	Starch type
2	2	1	1.106	26.54	71.38	65.9	0.5	4.6	29.0	0.	
		2	–	–	–	65.7	0.5	4.6	28.9	0.4	Thin boiling
		3	–	–	–	65.7	0.5	4.6	28.9	0.4	Waxy-maize
		4	–	–	–	65.7	0.5	4.6	28.9	0.4	Thick boiling
		5	–	–	–	72.6	0.5	5.1	21.8	0.	
		6	–	–	–	72.3	0.5	5.1	21.7	0.4	Thin boiling
3	1	1	1.112	20.14	72.10	72.6	0.5	5.1	21.8	0.	
		2	–	–	–	72.3	0.5	5.1	21.7	0.4	Thin boiling
		3	–	–	–	72.3	0.5	5.1	21.7	0.4	Waxy-maize
		4	–	–	–	72.3	0.5	5.1	21.7	0.4	Thick boiling
		5	–	–	–	65.9	0.5	4.6	29.0	0.	
		6	–	–	–	65.7	0.5	4.6	28.9	0.4	Thin boiling
3	2	1	1.113	20.99	70.42	67.7	0.5	4.7	27.1	0.	
		2	–	–	–	67.5	0.5	4.7	27.0	0.4	Thin boiling
		3	–	–	–	67.5	0.5	4.7	27.0	0.4	Waxy-maize
		4	–	–	–	67.5	0.5	4.7	27.0	0.4	Thick boiling
		5	–	–	–	61.8	0.4	4.3	33.4	0.	
		6	–	–	–	61.6	0.4	4.3	33.3	0.4	Thin boiling
4	1	1	1.095	24.89	79.04	72.6	0.5	5.1	21.8	0.	
		5	–	–	–	72.3	0.5	5.1	21.7	0.4	Thick boiling
		6	–	–	–	65.9	0.5	4.6	29.0	0.	
		7	–	–	–	65.7	0.5	4.6	28.9	0.4	Thin boiling
		8	–	–	–	65.7	0.5	4.6	28.9	0.4	Waxy-maize
		9	–	–	–	65.7	0.5	4.6	28.9	0.4	Thick boiling

[1] *The specific gravity, AIS and moisture were determined on a representative sample of each harvest.*

APPENDIX TABLE B. Specific gravity, percentage of alcohol insoluble solids (AIS), and formulation of raw sweet corn of the variety Deep Gold (1958 season).

Planting	Harvest	Batch	Specific Gravity[1]	AIS (%)[1]	FORMULATION					
					Corn (%)	Salt (%)	Sugar (%)	Water (%)	Starch (%)	Starch type
1	1	1	1.060	17.47	72.6	0.5	5.1	21.8	0.	–
		2	–	–	72.3	0.5	5.0	21.7	0.4	Waxy-maize
		3	–	–	72.3	0.5	5.0	21.7	0.4	Thin boiling
		4	–	–	71.9	0.5	5.0	21.6	1.0	Waxy-maize
		5	–	–	71.9	0.5	5.0	21.6	1.0	Thin boiling
		6	–	–	71.6	0.5	5.0	21.5	1.4	Waxy-maize
1	2	1	1.080	18.29	67.7	0.5	4.7	27.1	0.	–
		2	–	–	67.5	0.5	4.7	27.0	0.4	Waxy-maize
		3	–	–	67.5	0.5	4.7	27.0	0.4	Thin boiling
		4	–	–	67.1	0.5	4.7	26.8	1.0	Waxy-maize
		5	–	–	67.1	0.5	4.7	26.8	1.0	Thin boiling
		6	–	–	66.8	0.5	4.7	26.7	1.4	Waxy-maize
		7	–	–	66.8	0.5	4.7	26.7	1.4	Thin boiling
1	3	1	1.095	23.16	67.7	0.5	4.7	27.1	0.	–
		2	–	–	67.5	0.5	4.7	27.0	0.4	Waxy-maize
		3	–	–	67.5	0.5	4.7	27.0	0.4	Thin boiling
		4	–	–	67.1	0.5	4.7	26.8	1.0	Waxy-maize
		5	–	–	67.1	0.5	4.7	26.8	1.0	Thin boiling
		6	–	–	66.8	0.5	4.7	26.7	1.4	Waxy-maize
		7	–	–	66.8	0.5	4.7	26.7	1.4	Thin boiling
		8	–	–	67.7	0.5	4.7	27.1	0.	–

[1] *The specific gravity and AIS were determined on a representative sample of each harvest.*

APPENDIX TABLE B.–Continued– Specific gravity, percentage of alcohol insoluble solids (AIS), and formulation of raw sweet corn of the variety Deep Gold (1958 season).

Planting	Harvest	Batch	Specific Gravity[1]	AIS (%)[1]	FORMULATION					
					Corn (%)	Salt (%)	Sugar (%)	Water (%)	Starch (%)	Starch type
3	1	1	1.063	17.20	72.6	0.5	5.1	21.8	0.	–
		2	–	–	72.3	0.5	5.0	21.7	0.4	Waxy-maize
		4	–	–	71.9	0.5	5.0	21.6	1.0	Waxy-maize
		5	–	–	71.9	0.5	5.0	21.6	1.0	Thin boiling
		6	–	–	71.6	0.5	5.0	21.5	1.4	Waxy-maize
		7	–	–	71.6	0.5	5.0	21.5	1.4	Thin boiling
4	1	1	1.068	13.17	72.6	0.5	5.1	21.8	0.	–
		2	–	–	72.3	0.5	5.0	21.7	0.4	Waxy-maize
		3	–	–	72.3	0.5	5.0	21.7	0.4	Thin boiling
		4	–	–	71.9	0.5	5.0	21.6	1.0	Waxy-maize
		5	–	–	71.9	0.5	5.0	21.6	1.0	Thin boiling
		6	–	–	71.6	0.5	5.0	21.5	1.4	Waxy-maize
		7	–	–	71.6	0.5	5.0	21.5	1.4	Thin boiling
5	1	1	1.080	15.92	78.3	0.5	5.5	15.7	0.	–
		2	–	–	78.0	0.5	5.5	15.6	0.4	Waxy-maize
		3	–	–	78.0	0.5	5.5	15.6	0.4	Thin boiling
		4	–	–	77.5	0.5	5.4	15.5	1.0	Waxy-maize
		5	–	–	77.5	0.5	5.4	15.5	1.0	Thin boiling
		6	–	–	77.1	0.5	5.4	15.4	1.4	Waxy-maize
		7	–	–	77.1	0.5	5.4	15.4	1.4	Thin boiling
		8	–	–	78.3	0.5	5.5	15.7	0.	–

[1] *The specific gravity and AIS were determined on a representative sample of each harvest.*

APPENDIX TABLE C. Consistency (Adams values) of canned cream style sweet corn at various 40° F. storage periods (1957 season).

Planting	Harvest	Batch	Filler		Storage Time		
			190°	78°	1 Day	4 Mo.	9 Mo.
			Consistency (Adams values)				
1	1	1	4.25	6.5	9.25	5.75	6.5
		2	6.75	8.5	9.5	8.5	7.75
		3	6.5	8.75	9.0	8.25	8.0
		4	6.75	8.0	8.0	6.5	3.75
		5	3.25	5.0	7.0	5.25	4.0
		6	7.5	9.0	10.0	10.0	8.25
		7	5.0	8.75	6.5	6.75	5.25
		8	5.25	8.0	9.5	6.75	6.5
		9	8.0	9.0	10.75	10.5	10.0
1	2	1	5.75	4.25	8.75	6.75	4.5
		2	6.0	3.5	9.5	7.75	7.25
		3	5.25	6.0	7.25	5.75	4.5
		4	4.25	3.75	8.5	6.5	4.5
		5	7.75	8.5	10.25	10.5	7.0
		6	8.5	9.75	11.25	11.25	11.75
		7	8.0	10.5	11.25	11.25	9.0
		8	7.25	8.5	10.0	10.25	7.0
		9	4.75	7.0	7.25	11.0	7.75
2	1	1	3.25	5.0	8.0	11.25	9.25
		2	6.5	7.5	9.25	11.75	10.75
		3	6.75	7.25	9.75	11.0	10.0
		4	6.25	6.0	11.0	10.75	11.0
		5	0.5	2.75	4.75	5.0	3.75
		6	3.5	2.75	7.75	8.5	7.75
		7	2.25	3.75	5.5	6.0	5.5
		8	1.5	2.5	3.5	5.0	4.75

APPENDIX TABLE C.–Continued–Consistency (Adams values) of canned cream style sweet corn at various 40° F. storage periods (1957 season).

Planting	Harvest	Batch	Filler		Storage Time		
			190°	78°	1 Day	4 Mo.	9 Mo.
			Consistency (Adams values)				
2	2	1	1.5	7.25	12.25	10.75	9.25
		2	2.5	7.5	12.75	10.0	9.0
		3	4.5	10.0	11.75	9.25	5.75
		4	3.75	6.75	9.25	6.75	5.5
		5	6.25	10.75	16.0	16.0	8.5
		6	5.75	11.0	16.0	16.0	13.0
3	1	1	0.25	2.75	–	6.25	4.25
		2	3.5	7.25	–	8.5	7.0
		3	5.25	10.0	–	9.5	8.25
		4	4.25	5.75	–	8.25	7.5
		5	0.0	0.0	–	4.5	4.75
		6	0.25	2.0	–	5.5	4.0
3	2	1	3.75	6.5	9.75	7.0	5.0
		2	6.0	7.25	10.75	9.0	7.5
		3	6.0	7.0	7.5	7.5	6.5
		4	6.0	8.0	10.75	9.5	5.0
		5	4.0	3.25	4.25	2.75	2.0
		6	5.25	4.75	6.25	4.25	3.75
4	1	1	2.25	4.25	6.75	5.5	3.5
		5	4.75	3.0	7.75	7.0	5.25
		6	0.0	2.0	2.0	2.0	0.75
		7	1.75	1.75	4.75	3.5	1.25
		8	2.5	4.5	3.5	3.5	2.0
		9	2.25	2.0	0.75	3.5	1.0

APPENDIX TABLE D. Percentage of alcohol insoluble solids (AIS) and the consistency (Adams values) of canned cream style sweet corn at various room temperature storage periods (1957 season).

Planting	Harvest	Batch	AIS (%)[1]	Filler		Storage Time		
				190°	78°	1 Day	4 Mo.	9 Mo.
				Consistency (Adams values)				
1	1	1	18.71	4.25	6.5	7.75	7.75	6.0
		2	–	6.75	8.5	7.75	6.75	10.5
		3	–	6.5	8.75	9.75	8.5	7.25
		4	–	6.75	8.0	11.5	8.0	7.0
		5	–	3.25	5.0	6.75	7.25	6.0
		6	–	7.5	9.0	10.0	9.5	7.75
		7	–	5.0	8.75	8.75	8.0	7.0
		8	–	5.25	8.0	10.0	6.25	7.75
		9	–	8.0	9.0	11.25	10.25	9.25
1	2	1	20.60	5.75	4.25	10.25	7.0	6.75
		2	–	6.0	3.5	7.5	8.5	8.5
		3	–	5.25	6.0	8.5	9.0	6.0
		4	–	4.25	3.75	8.5	7.25	5.75
		5	–	7.75	8.5	13.75	10.25	12.0
		6	–	8.5	9.75	11.25	11.25	10.5
		7	–	8.0	10.5	11.75	13.25	11.5
		8	–	7.25	3.75	10.5	8.0	8.75
		9	–	4.75	7.0	5.25	9.25	5.0
2	1	1	18.64	3.25	5.0	6.75	3.5	7.0
		2	–	6.5	7.5	8.0	11.0	10.25
		3	–	6.75	7.25	8.0	10.25	10.25
		4	–	6.25	6.0	10.75	12.5	10.25
		5	–	0.5	2.75	3.75	5.5	4.25
		6	–	3.5	2.75	5.5	6.5	8.25
		7	–	2.25	3.75	4.75	7.0	6.75
		8	–	1.5	2.5	3.5	6.75	4.0

[1] *The AIS was determined on a representative sample of each harvest.*

APPENDIX TABLE D.–Continued–Percentage of alcohol insoluble solids (AIS) and the consistency (Adams values) of canned cream style sweet corn at various room temperature storage periods (1957 season).

Planting	Harvest	Batch	AIS (%)[1]	Filler		Storage Time		
				190°	78°	1 Day	4 Mo.	9 Mo.
				Consistency (Adams values)				
2	2	1	20.72	1.5	7.25	9.5	8.75	9.0
		2	–	2.5	7.5	9.5	7.5	7.75
		3	–	4.5	10.0	10.75	10.0	11.5
		4	–	3.75	6.75	8.75	6.0	7.25
		5	–	6.25	10.75	16.0	11.75	9.75
		6	–	5.75	11.0	16.0	13.5	12.75
3	1	1	20.14	0.25	2.75	–	6.0	4.25
		2	–	3.5	7.25	–	8.75	7.75
		3	–	5.25	10.0	–	9.25	8.0
		4	–	4.25	5.75	–	9.5	6.5
		5	–	0.0	0.0	–	6.0	4.0
		6	–	0.25	2.0	–	8.25	5.0
3	2	1	20.99	3.75	6.5	9.25	6.75	8.25
		2	–	6.0	7.25	10.25	8.25	8.5
		3	–	6.0	7.0	9.0	8.0	7.75
		4	–	6.0	8.0	9.75	9.5	8.0
		5	–	4.0	3.25	3.0	4.0	4.0
		6	–	5.25	4.75	7.5	5.75	4.75
4	1	1	20.44	2.25	4.25	5.75	4.0	3.5
		5	–	4.75	3.0	7.5	7.5	6.5
		6	–	0.0	2.0	1.25	0.5	0.5
		7	–	1.75	1.75	2.75	3.0	3.0
		8	–	2.5	4.5	3.75	5.25	3.5
		9	–	2.25	2.0	2.5	4.0	2.75

[1] *The AIS was determined on a representative sample of each harvest.*

APPENDIX TABLE E. Consistency (Adams values) of canned cream style sweet corn at various 90° F. storage periods (1957 season).

Planting	Harvest	Batch	Filler		Storage Time		
			190°	78°	1 Day	4 Mo.	9 Mo.
			Consistency (Adams values)				
1	1	1	4.25	6.5	9.25	6.0	6.0
		2	6.75	8.5	10.0	8.5	8.25
		3	6.5	8.75	10.75	9.25	8.75
		4	6.75	8.0	10.75	9.0	8.5
		5	3.25	5.0	6.75	6.0	5.75
		6	7.5	9.0	10.5	9.5	8.25
		7	5.0	8.75	9.25	8.0	7.5
		8	5.25	8.0	9.0	7.25	7.75
		9	8.0	9.0	12.5	10.75	9.75
1	2	1	5.75	4.25	9.0	7.75	6.75
		2	6.0	3.5	9.5	8.25	8.5
		3	5.25	6.0	9.5	8.75	8.5
		4	4.25	3.75	9.5	8.75	7.0
		5	7.75	8.5	11.25	10.25	10.0
		6	8.5	9.75	11.75	11.0	10.25
		7	8.0	10.5	12.25	12.0	11.75
		8	7.25	8.75	10.25	10.25	8.75
		9	4.75	7.0	7.25	10.5	5.25
2	1	1	3.25	5.0	5.75	8.75	8.25
		2	6.5	7.5	8.0	10.0	9.25
		3	6.75	7.25	10.75	11.0	10.5
		4	6.25	6.0	11.75	12.0	11.25
		5	0.5	2.75	5.0	5.0	3.0
		6	3.5	2.75	7.0	8.25	6.0
		7	2.25	3.75	5.0	2.5	6.5
		8	11.5	2.5	4.75	5.5	4.75

APPENDIX TABLE E.–Continued–Consistency (Adams values) of canned cream style sweet corn at various 90° F. storage periods (1957 season).

Planting	Harvest	Batch	Filler		Storage Time		
			190°	78°	1 Day	4 Mo.	9 Mo.
			Consistency (Adams values)				
2	2	1	1.5	7.25	10.75	11.0	9.25
		2	2.5	7.5	12.0	11.5	10.75
		3	4.5	10.0	12.75	9.75	8.25
		4	3.75	6.75	10.0	8.25	9.75
		5	6.25	10.75	16.0	10.25	9.25
		6	5.75	11.0	16.0	12.25	12.75
3	1	1	0.25	2.75	–	6.75	4.75
		2	3.5	7.25	–	10.0	2.0
		3	5.25	10.0	–	8.25	9.5
		4	4.25	5.75	–	9.25	7.75
		5	0.0	0.0	–	6.0	5.5
		6	0.25	2.0	–	6.75	5.25
3	2	1	3.75	6.5	8.75	9.0	7.5
		2	6.0	7.25	9.5	9.75	8.75
		3	6.0	7.0	7.25	10.0	7.25
		4	6.0	8.0	10.25	9.0	7.5
		5	4.0	3.25	3.5	4.5	1.5
		6	5.25	4.75	4.25	5.5	4.75
4	1	1	2.25	4.25	6.0	5.75	3.25
		5	4.75	3.0	5.25	8.0	6.75
		6	0.0	2.0	1.25	2.25	0.75
		7	1.75	1.75	3.5	2.0	2.25
		8	2.5	4.5	3.0	3.25	3.5
		9	2.25	2.0	1.0	2.5	1.5

APPENDIX TABLE F. Consistency (Adams values) of canned cream style sweet corn at various 40° F. storage periods (1958 season).

Planting	Harvest	Batch	Filler		Storage Time (In Weeks)						
			190°	78°	2	4	6	8	10	12	16
			Consistency (Adams values)								
1	1	1	0	0	0	0.5	0.5	1.25	1.5	.25	1.5
		2	0	3.25	3.5	3.75	5.0	4.5	5.5	3.75	3.5
		3	0	1.25	1.25	2.75	3.75	2.5	3.25	3.0	2.5
		4	1.25	4.0	5.5	4.0	6.0	5.75	6.0	7.0	6.0
		5	2.25	4.0	5.5	5.5	6.75	5.25	6.0	6.5	7.25
		6	6.25	8.0	9.75	10.75	12.0	11.25	11.0	11.25	11.25
1	2	1	0	0	1.0	0	3.25	1.75	3.0	2.25	2.5
		2	0	0	2.0	2.25	2.5	3.5	3.25	3.75	2.0
		3	0	0	3.5	3.0	1.0	2.5	3.0	3.25	2.5
		4	0.75	0.5	4.75	7.0	6.25	5.5	5.0	6.0	3.75
		5	0.5	1.75	6.75	7.5	7.0	7.5	7.25	8.5	6.5
		6	6.0	6.75	9.75	9.75	10.0	10.0	10.0	10.25	9.5
		7	2.5	2.75	8.25	10.25	9.5	9.0	10.25	10.75	9.75
1	3	1	0	2.0	3.75	2.0	3.0	2.5	2.5	3.0	0
		2	0	2.0	3.75	3.75	4.75	3.25	3.5	3.75	2.5
		3	1.5	3.0	4.75	2.5	4.0	3.5	3.75	3.5	1.75
		4	3.0	6.25	5.75	7.5	7.5	7.5	7.5	6.25	5.0
		5	4.5	5.5	7.5	9.5	9.5	9.0	8.75	8.75	6.0
		6	5.0	7.0	8.25	9.5	9.25	8.5	9.75	8.75	8.5
		7	6.5	8.25	10.0	10.0	10.5	9.25	10.0	9.5	9.0
		8	0	2.25	2.75	4.0	4.25	2.5	2.75	3.25	2.0
3	1	1	0	0	1.75	0.75	0	1.0	0	0.5	0.5
		2	0	4.0	2.0	2.25	2.75	1.5	2.25	2.5	1.5
		4	0	2.5	5.0	4.25	4.25	5.25	5.0	5.0	4.5
		5	1.5	4.0	4.0	4.25	3.75	4.75	5.0	5.0	3.5
		6	5.25	9.25	10.0	10.25	9.25	6.0	6.0	7.75	9.0
		7	5.0	8.0	8.75	8.5	9.25	9.0	10.0	9.0	8.5

APPENDIX TABLE F.–Continued–Consistency (Adams values) of canned cream style sweet corn at various 40° F. storage periods (1958 season).

Planting	Harvest	Batch	Filler		Storage Time (In Weeks)						
			190°	78°	2	4	6	8	10	12	16
			Consistency (Adams values)								
4	1	1	0	0	0	0	0	0	0	0	0
		2	0.5	2.0	1.5	1.25	2.0	2.0	1.0	1.0	0.75
		3	0	0.75	0.75	0.5	0.5	2.0	0.5	0	0
		4	0	4.0	4.25	4.25	4.5	4.5	4.0	4.5	4.0
		5	0.25	3.0	3.75	4.25	4.0	4.5	4.25	4.0	4.0
		6	3.75	6.25	7.25	7.75	8.0	6.5	7.0	6.5	6.25
		7	3.0	5.25	6.0	6.5	6.25	6.5	7.0	6.75	6.25
5	1	1	0	1.75	1.5	0.5	1.0	1.75	0.25	0.25	0.75
		2	1.75	4.5	4.25	4.0	4.5	5.0	4.75	3.75	4.5
		3	1.25	3.75	3.25	3.5	3.75	3.25	3.0	1.75	3.0
		4	4.0	8.0	8.0	8.0	8.0	7.5	7.25	5.75	5.75
		5	4.25	6.0	9.25	8.5	9.0	8.75	9.25	8.75	8.75
		6	7.5	8.75	10.0	10.5	10.25	11.0	11.0	10.25	9.25
		7	7.5	9.5	10.25	11.0	10.75	12.0	11.75	11.0	11.0
		8	0	3.5	4.5	3.5	4.0	4.0	5.5	1.75	5.0

APPENDIX TABLE G. Consistency (Adams values) of canned cream style sweet corn at various room temperature storage periods (1958 season).

Planting	Harvest	Batch	Filler		Storage Time (in weeks)					Storage Time (in weeks)										
			190°	78°	2	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24
			Consistency (Adams values)							Consistency (Adams values)										
1	1	1	0	0	1.25	1.0	1.0	0.25	2.25	2.0	1.5	0.75	2.25	0	2.0	0.5	0.25	0	2.0	0
		2	0	3.25	3.5	3.75	3.75	4.75	3.0	3.75	4.5	4.5	4.25	4.25	4.0	0	3.5	5.25	4.5	5.0
		3	0	1.25	2.75	0.25	2.25	3.25	4.0	1.75	2.5	3.75	2.75	2.25	2.5	2.25	2.5	2.5	1.25	3.0
		4	1.25	4.0	5.25	4.0	5.0	6.0	4.5	4.0	4.75	5.5	6.0	6.25	5.5	4.75	5.0	5.5	5.25	5.0
		5	2.25	4.0	5.0	4.0	4.5	6.75	6.25	4.5	4.5	5.5	5.0	5.0	5.25	4.75	6.0	5.75	4.5	4.75
		6	6.25	8.0	9.5	9.0	10.0	10.0	9.25	9.25	9.5	8.75	9.5	10.0	9.75	9.75	9.25	9.25	9.5	9.5
1	2	1	0	0	0	0	–	1.75	–	0	–	0.75	–	0	2.5	1.25	0	0	1.0	1.0
		2	0	0	2.25	1.75	–	0	–	1.25	–	2.5	–	2.0	1.5	0	2.25	2.75	1.75	3.0
		3	0	0	2.75	1.25	–	2.75	–	1.75	–	2.25	–	2.0	2.25	2.5	1.75	3.0	1.5	1.25
		4	0.75	0.5	4.75	4.5	–	4.75	–	3.0	–	4.75	–	4.75	4.75	4.0	4.0	3.5	3.25	5.75
		5	0.5	1.75	6.5	6.0	–	5.25	–	4.5	–	6.0	–	6.75	5.5	4.25	5.5	4.5	5.25	3.75
		6	6.0	6.75	8.5	9.0	–	8.5	–	8.75	–	9.0	–	9.0	9.0	8.25	9.25	9.0	9.0	9.0
		7	2.5	2.75	8.75	8.5	–	7.5	–	8.25	–	9.0	–	8.0	8.75	8.75	8.5	8.0	8.5	7.75
1	3	1	0	2.0	4.25	3.0	3.0	3.25	2.75	2.0	3.5	2.75	2.5	3.0	2.75	2.75	3.75	1.5	1.25	2.0
		2	0	2.0	4.75	3.75	3.75	4.25	3.5	3.0	3.0	3.5	3.5	3.25	2.25	4.0	4.25	3.0	2.25	3.25
		3	1.5	3.0	4.0	4.75	5.25	4.0	3.75	2.25	3.5	4.25	4.5	3.0	3.5	4.5	3.5	3.5	4.25	3.25
		4	3.0	6.25	6.25	3.75	6.0	6.75	5.5	6.0	7.0	6.0	5.75	5.75	6.0	7.0	7.0	6.5	6.75	6.75
		5	4.75	5.5	7.0	7.75	7.5	8.0	6.5	7.0	7.25	7.75	7.25	7.75	7.5	6.5	7.75	5.5	6.75	7.0
		6	5.0	7.0	8.0	8.5	8.25	7.25	6.75	8.25	8.25	5.75	8.5	8.25	9.0	8.0	8.75	8.25	7.75	8.5
		7	6.5	8.25	9.5	9.0	8.0	9.25	9.5	8.0	9.25	9.5	7.5	10.0	9.5	6.0	9.0	7.0	9.0	8.25
		8	0	2.25	4.0	0.75	3.5	2.25	2.25	0	3.0	3.5	2.5	3.0	3.25	2.25	2.0	3.5	2.75	2.25
3	1	1	0	0	1.5	0	1.25	1.0	1.25	0.50	1.0	1.75	1.0	0.5	0	0	1.75	0	0.5	0
		2	0	4.0	2.75	2.25	2.0	2.5	3.0	2.25	2.25	1.0	3.0	1.5	2.0	2.0	2.75	2.0	1.25	2.25
		4	0	2.5	4.0	4.0	4.0	3.25	4.75	3.75	3.75	3.75	5.0	4.75	4.0	4.5	5.0	4.0	4.0	4.5
		5	1.5	4.0	3.5	4.5	4.0	5.25	5.25	4.5	4.25	5.5	5.0	3.5	4.0	3.75	2.5	3.25	2.25	3.75
		6	5.25	9.25	7.5	5.25	7.0	8.0	7.75	8.0	4.75	7.25	7.25	9.5	6.25	9.0	10.25	10.0	8.75	7.75
		7	5.0	8.0	7.75	7.5	7.25	7.25	6.75	7.0	8.0	7.5	8.25	7.0	8.0	5.75	6.25	6.5	6.25	6.75
4	1	1	0	0	0	0	0	0	0.5	0	0	0	0	0.25	0.5	0.75	0.25	1.25	0.25	0
		2	0.5	2.0	1.75	2.0	1.75	2.25	1.0	1.5	1.25	1.25	1.25	1.25	0.75	2.5	2.25	2.5	1.25	1.5
		3	0	0.75	0.75	0.75	1.0	0.25	1.25	0.5	0	0	0.25	0	0.25	0.25	0.5	0.5	0	0.5
		4	0	4.0	5.0	4.5	4.5	5.25	4.75	4.75	2.75	3.25	4.25	5.0	4.75	4.75	5.75	5.25	4.75	5.25
		5	0.25	3.0	3.5	4.25	3.5	3.75	3.25	3.5	3.0	3.25	4.5	2.25	2.0	2.0	2.25	3.5	0.75	2.25
		6	3.75	6.25	7.25	6.75	6.5	6.0	5.5	6.75	7.0	6.0	5.25	6.0	6.75	6.5	6.5	7.25	6.75	6.25
		7	3.0	5.25	5.75	4.75	5.0	5.0	5.75	5.75	5.5	4.0	5.5	3.75	5.0	5.0	4.75	5.0	5.0	5.25
5	1	1	0	1.75	2.5	2.5	3.75	1.25	2.25	2.75	3.25	2.5	3.25	1.25	1.25	3.75	3.25	2.75	3.5	4.25
		2	1.75	4.5	5.0	4.5	6.75	6.25	4.25	5.0	4.75	4.5	5.0	5.75	6.5	5.75	6.25	4.5	6.0	6.0
		3	1.25	3.75	4.5	5.0	4.25	4.0	4.75	4.75	5.0	4.0	4.0	3.75	5.25	5.0	3.5	4.75	5.0	5.0
		4	4.0	8.0	8.75	8.5	9.0	9.0	8.25	8.25	9.25	8.5	8.75	8.75	7.75	6.5	7.5	8.25	8.75	8.25
		5	4.25	6.0	7.75	7.75	8.5	7.25	6.0	7.25	8.25	8.5	6.75	7.5	8.75	8.75	8.0	8.0	6.75	8.5
		6	7.5	8.75	9.0	9.5	9.0	9.25	10.0	9.75	10.0	8.75	10.25	9.5	9.0	9.5	9.5	8.0	9.0	9.5
		7	7.5	9.5	9.5	10.0	10.75	10.25	10.0	10.25	10.5	8.25	9.75	10.0	9.5	9.75	9.25	9.25	8.75	9.25
		8	0	3.5	3.5	4.5	4.25	4.5	2.75	4.25	6.0	2.5	2.5	3.25	5.0	4.75	4.5	1.25	5.25	5.5

APPENDIX TABLE H. Consistency (Adams values) of canned cream style sweet corn at various 90° F. storage periods (1958 season).

Planting	Harvest	Batch	Filler		Storage Time (in weeks)						
			190°	78°	2	4	6	8	10	12	16
			Consistency (Adams values)								
1	1	1	0	0	0	0.75	0.25	0.25	0.25	0.5	0.25
		2	0	3.25	3.75	4.75	4.0	4.25	3.0	4.5	3.0
		3	0	1.25	2.0	0	3.5	2.75	0.75	0.5	1.75
		4	1.25	4.0	5.0	5.0	6.0	6.75	5.0	5.5	5.5
		5	2.25	4.0	5.0	4.0	4.5	4.0	4.25	4.75	3.75
		6	6.25	8.0	8.5	8.75	8.75	8.75	9.25	8.25	9.25
1	2	1	0	0	2.25	2.5	1.0	0.75	0	1.5	1.5
		2	0	0	4.0	2.5	3.5	3.0	3.25	3.0	2.0
		3	0	0	2.0	2.0	2.5	1.25	1.75	1.75	1.0
		4	0.75	0.5	4.0	3.75	4.25	4.5	3.5	4.75	3.75
		5	0.5	1.75	5.75	5.5	5.5	6.0	6.0	6.5	5.25
		6	6.0	6.75	8.0	7.75	8.75	9.0	9.0	8.0	8.0
		7	2.5	2.75	7.0	6.5	7.0	6.75	5.75	7.0	6.5
1	3	1	0	2.0	3.25	3.75	3.75	3.0	3.25	3.25	2.0
		2	0	2.0	4.0	3.5	2.75	3.25	4.75	4.0	3.25
		3	1.5	3.0	4.5	3.0	1.75	4.0	3.0	3.25	1.0
		4	3.0	6.25	8.25	7.25	6.5	7.25	7.5	7.0	6.75
		5	4.5	5.5	8.0	7.25	6.75	8.0	8.0	6.0	7.5
		6	5.0	7.0	7.75	8.0	8.25	8.25	7.5	9.0	8.5
		7	6.5	8.25	9.5	9.5	9.25	8.5	9.0	9.25	8.0
		8	0	2.25	4.0	4.25	0.5	2.5	0.75	2.75	1.25
3	1	1	0	0	0.25	0	0	0.25	1.0	0	0
		2	0	4.0	2.0	2.75	2.25	2.5	2.5	2.75	2.25
		4	0	2.5	4.25	4.0	3.0	5.0	4.25	4.75	3.75
		5	1.5	4.0	.25	3.5	3.5	3.5	0.5	3.75	2.75

APPENDIX TABLE H–Continued–Consistency (Adams values) of canned cream style sweet corn at various 90° F. storage periods (1958 season).

Planting	Harvest	Batch	Filler		Storage Time (in weeks)						
			190°	78°	2	4	6	8	10	12	16
			Consistency (Adams values)								
4	1	1	0	0	0	0.75	0.25	1.0	1.5	0	0.25
		2	0.5	2.0	2.5	1.75	1.75	2.5	2.5	2.0	1.5
		3	0	0.75	0	0	0	0	0.75	0.5	0
		4	0	4.0	4.5	4.5	3.5	3.75	5.5	3.5	3.5
		5	0.25	3.0	4.75	3.5	4.25	3.75	3.5	3.0	3.25
		6	3.75	6.25	7.75	7.0	7.0	7.0	7.0	6.5	7.0
		7	3.0	5.25	5.5	5.0	4.5	4.75	5.0	3.75	4.75
5	1	1	0	1.75	2.25	2.75	0.5	1.5	2.25	1.25	1.25
		2	1.75	4.5	4.75	5.0	5.0	7.5	6.0	5.0	4.5
		3	1.25	3.75	3.25	4.75	5.5	3.5	4.0	2.75	4.0
		4	4.0	8.0	8.0	8.0	8.5	9.0	8.0	6.75	7.0
		5	4.25	6.0	8.5	8.5	8.75	5.5	8.5	8.0	7.75
		6	7.5	8.75	10.25	10.0	9.75	9.75	10.25	10.0	10.0
		7	7.5	9.5	8.75	8.25	8.0	9.0	8.5	8.5	9.0
		8	0	3.5	2.25	4.25	4.75	4.0	5.75	5.0	5.25

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